



# SURGERY

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# SURGERY

## GYNECOLOGY AND OBSTETRICS

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### PURPOSEFUL SPLINTING FOLLOWING INJURIES OF THE HAND

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Chicago, Illinois

NO discussion of the importance of rest in the treatment of injured hands and of methods of securing it would be complete without an acknowledgment of our indebtedness to the teachings of Hugh Owen Thomas, and it is fitting to remind ourselves again of the extent of that obligation.

The story of Hugh Owen Thomas goes back more than 200 years when a dark complexioned Welsh boy,<sup>1</sup> Evan Thomas by name, began to show a special aptitude for caring for the sick and injured animals about the farm. As he grew older his reputation spread, and, reversing the procedure of the famed Dr. James Doolittle, who found animals more to his liking than humans, Evan Thomas gradually developed a practice among the farmers of the countryside, a practice which eventually extended over North Wales and neighboring parts of England. On his death, in 1814, a tablet was erected to his memory.

"... who, in humble life, without the aid of education or any other advantages, by an extraordinary gift of nature, acquired such a knowledge of the human frame as to become a most skilful Bone-

setter, whereby he rendered himself pre-eminently useful to his fellow-creatures."

Evan Thomas was followed by five sons who carried on his work. Of these, Richard, considered the most skilful, had three sons and four daughters. Except for the eldest, Evan, they carried on the family tradition in their own neighborhoods. Evan at the age of 19 went to Liverpool to seek wider fields for his talents. He began by treating the injuries of his fellow workers in the foundry where he had found an opportunity to work, and so successful was he that he soon was able to set up in practice as a bonesetter. He developed an extensive following among the dock workers and laborers of Liverpool. Here, in 1832, he married a Miss Roberts, and here his five sons were born, of whom the eldest, Hugh Owen Thomas, born August 23, 1834, is our hero.

Hugh Owen was a silent lad of rather frail physique, but an ardent student and a lover of books and nature. An intellectually gifted and greatly loved mother and a thoughtful, kindly schoolmaster were potent factors in developing the idealism, the stern sense of duty, the constant self criticism and unwillingness to be satisfied with any achievement short of perfection, the love of poetry and music which were outstanding characteristics of the boy and man.

From the Department of Surgery, Northwestern University Medical School.

<sup>1</sup>There is an oft repeated legend that Evan Thomas was of Spanish descent, the older of two brothers, sole survivors of a shipwreck on the rocky coast of Anglesea in Wales.





HUGH OWEN THOMAS  
1834-1891

ischiurum. with suitable instruments the arm stems are cut and the ends introduced into the patient's boot. The whole operation is complete in less than five minutes. The boot has been prepared beforehand by having a tube placed in the heel and a vertical V-shaped gap cut out from the back of the upper while the front of the boot is slit up to the toe—all these preparations being essential to avoid friction. This, as Thomas put it, takes less time than it does for a smith to 'blow up his fire.' The next patient may be a case of intestinal obstruction who is visited five or six times a day. And so the round went on until breakfast, which consisted of a cup of tea and a couple of bananas. The meal rarely lasted for more than ten minutes, but he always found time to relate any comic adventure that may have occurred on the round, and to glance at the more important items in his morning paper.

"From nine until two he was at work in his room, where he met with every variety of case both medical and orthopaedic. During the morning he saw between thirty and forty patients, prescribed and dispensed medicine for them, dressed their wounds, reduced their fractures and dislocations, and gave each one his individual attention. Long experience on the surgical side had enabled him to make a rapid diagnosis and to ask only those questions which had a direct bearing on the case.

"His methods of examination, although rapid, were very gentle. He had wonderful knowledge of the movements that give rise to pain and of the value of an accurate grip in steadying muscle and supporting a limb. Whenever he had to handle a fracture he persuaded the patient to abstain from all effort, and to leave the muscles slack, knowing full well how often pain is self-inflicted.

"There was hardly a morning without one or two cases of fracture, and these were always expeditiously dealt with without anaesthesia.

"The equipment of the establishment in Nelson Street was such that no outside aid was needed. There was a blacksmith at work in a smithy, a saddler finishing off the various splints, and duties of others were the making of adhesive plasters and bandages, and the preparation of dressings. There were splints of every size to suit any possible deformity that might appear or for any fracture that might have occurred. No matter from what distance a patient came, no matter whether the affection be spinal caries, hip disease, or fractured thigh, he was always able to return home in an hour or so, most accurately fitted with a simple and appropriate splint.

"At half-past two people were seen at their homes without delay, for at 4.30 he must be back at Nelson Street.

"His last meal finished he hurried from the table to see his evening flock who continued to come until eight o'clock. Although most of these were Club members quite a number of them were surgical cases, but the patients had more confidence in him than in hospitals. In spite of his strenuous day he is bright

and cheery, for he loves to chat with the working man on the character and scope of his work. Usually at eight he made his last round, confining his visits to those cases critical in themselves, or interesting from the point of view of investigation. It was always interesting because compound fractures and intestinal obstruction were often encountered.

"From nine-thirty to twelve he either worked in his lathe room, which was fitted with the most modern machinery, making new surgical instruments or repairing old ones, or he would find his way to the library to read and write.

"This, then, presented an ordinary day's work, and to anyone who knew Thomas, with his frail body and anxious mind, entering whole-heartedly into his patients' troubles and always unsparing of effort, it is a marvel how he could continuously work at such pressure for over thirty years—for it must be remembered that he never took a holiday. During all these years of work he was only away from home some six nights, and even on Sunday mornings he had his free clinic when nearly two hundred cases, many of them of great interest, collected from all parts. It was a great scene, and surgeons who were present never ceased talking of the marvels they had witnessed, for Thomas was years ahead of his time and the results of his treatment of fractures and tuberculous arthritis seemed then little less than miracles.

"He used to long for Sunday evenings, which he always devoted to music. His wife sang while he played the flute. These evenings gave him intense delight, for he was passionately fond of music and knew all the operas well, but the night nearly always closed with Welsh airs. In later years when he, as he put it, got 'too tired to blow' he went to bed early and read, while his niece played for him, and before he slept he always called for 'The Dead March in Saul.' He possessed three most beautiful silver flutes, and it is interesting to note that he specially designed some of the machinery of the stops to simplify the movements."

For thirty years he kept up this strenuous pace, happy in his work and in his home, presided over by his one confidant, the gracious and beautiful Elizabeth Thomas. Then, exposure to cold while on a consultation in a neighboring town, pneumonia of brief duration, death—January 6, 1891.

Thomas' claim to enduring fame is securely based on his logical and successful methods of treatment of disease—methods which were unknown to or unrecognized by his contemporaries, but which today are accepted as sound and correct. At the very basis of his treatment was the principle of maintaining complete rest of injured and inflamed tissues. Not only did he insist upon rest for injured and

From the age of 13 to 17 he attended the college at New Brighton, and subsequently was apprenticed to his maternal uncle, Dr Owen Roberts, surgeon to the Workhouse Infirmary at St Asaph. This association with a stimulating personality, a physician with an extensive practice and a scholarly mind, was another fortunate opportunity for this earnest young student.

Evan Thomas, the silent serious minded father wisely and generously decided that his sons should have a medical education and become qualified practitioners. Wisely, because the constantly increasing friction with the medical profession and the handicaps under which he himself labored as a result of his limited medical training made him realize that the opportunities for the bonesetter were steadily diminishing, generously, because he must have foreseen that eventually it might mean a parting of the ways between the unschooled bonesetter and the sons educated in the most advanced medical institution of his day. Such a parting from his eldest son eventually came, with sorrow and unhappiness for both.

At the age of 21 Thomas entered the University of Edinburgh. Symes, Spence, Simpson and Goodair then held professorships, Lister was house surgeon to Symes. There in rooms on the top floor of one of the tall houses so common in Edinburgh, on an allowance of ten shillings a week, he lived during the two years of the prescribed medical course. Nothing impressed him so much as the number of amputations constantly performed for inflammation and diseases of the joints—conditions he had seen so often successfully managed by conservative treatment in his father's practice.

After two years at Edinburgh, twelve months at University College in London and a period of study in Paris he joined his father in practice at Liverpool. Before two years had passed the parting of the ways came and in 1859 Hugh Owen set up in practice for himself at 24 Hardy Street.

Soon he was as busy as his heart could wish. A number of clubs and organizations of workmen chose him as their medical officer. In 1866 he was compelled to seek larger quarters and moved to the house at 11 Nelson Street—

the house which has become almost a shrine to every man interested in the surgery of the extremities, the bones and joints. To it he added consulting rooms and a workshop, the latter fitted with every possible appliance for fashioning the splints which played so large a part in his treatment of injuries and diseases of the bones and joints.

His nephew, Sir Robert Jones, who joined him as an apprentice at the age of 15, has left this graphic picture of the man and his work.

In appearance Hugh Owen Thomas was a striking figure. He was thin and pale, about five feet four in height. His features were refined and clear cut with an intellectual forehead which receded slightly and dark grey eyes which were capable of great expression, sometimes sad and thoughtful but often alert and full of fire. His slight moustache was dark and his spare beard pointed. He always wore a closely buttoned black frock coat and a peaked cap to shelter his tender eyes from the light. His manner had been described as brusque but it was not so. He was quick and abrupt and fired his questions and answers briskly but he never repelled. He was loved by children. Always a good listener and most tolerant of criticism he had no patience with dogmatic fools.

A personal sketch would not be complete without an average day's work from early morning till late at night. At six o'clock in the morning he was mounted in a dog cart which had been built by his own smith to his own design on his own premises. He had a list of ten or twelve addresses to be visited before breakfast. It often happened that when he knocks at the door usually with his bare knuckles an empty milk can was handed to him. But as a rule they knew his knock. The patient may have a broken leg, intestinal obstruction or pneumonia. There was always time for a cheery word of advice and admonition. If it was a broken thigh the extensions might want tightening, pressure pads adjusted and many warnings were sure to be given to the household that no bandage was to be meddled with. Another house and he might find that the bandage had been loosened in a case of Pott's fracture. The surgeon stormed and the patient was immediately penitent. He was no longer to be trusted however so the bandage is reapplied and a large pin fastens it but before the surgeon leaves a large blob of sealing wax covers the pin and with a signet ring removed from his finger it is sealed with the initials H.O.T. Another visit and Thomas might be seen carrying a boot in one hand and a box containing enormous cutting shears in the other hand. He is about to transform a bed splint into a caliper in a case of tuberculous knee for the time for walking has come. The bandages are undone and the ring of the splint is pressed hard upon the tuberosity of the

of its own weight and because of the injury of tendons and joint capsules into volar flexion—all cry for support in a position which relaxes the injured tissues, and yet the application of a splint is not considered.

Failure to recognize the importance of rest and relaxation of injured tissues is not limited to senior medical students. The house officer sees a patient with extensor tendons of ring and little fingers divided over the middle of the metacarpus. He sutures the tendons, closes the wound and bandages the hand. The idea of a simple splint to relieve tension on the sutured tendons (Fig 1) does not occur to him. The orthopedic resident late in the day sees a nurse who has just sustained a glass cut over the dorsum of the metacarpophalangeal joint and who cannot extend the thumb. He realizes that the extensor pollicis longus has been divided, but bandages the hand and tells her to report to the chief in the morning. The idea of a splint to relax the muscle whose tendon has been divided does not occur to him. The attending surgeon operates upon a patient with radial nerve divided at the middle of the arm. He sutures the nerve and tells the house officer to close the wound. A splint to relax the paralyzed extensor muscles (Fig 2) is forgotten and the patient is discharged from the hospital a week later with a healing wound but a hand limp in volar flexion. A general surgeon sees a patient with division of flexor tendons and median and ulnar nerves on the volar aspect of the wrist. He sutures the tendons and splints the part with wrist and fingers completely extended. If he glanced at his own hand at rest on the table or considered the position of the fingers when relaxed he would realize that complete extension of the fingers puts tension on the flexor tendons and muscles, and that if he immobilizes the fingers in such a position after suture of the flexor tendons either the sutures will give way or they will cut through the tendons and permit complete separation of the sutured ends.

The cases cited illustrate some of the important indications for the use of splints in the treatment of injuries and infections of the hand, but the purposeful use of splints involves still more than the well recognized principle of rest of injured tissues. Of equal

importance with the care of tissues which have suffered a direct injury is the constant and prolonged relaxation of muscles whose nerve supply has been divided. The return of function, which one anticipates as regenerating nerve axons again grow downward into paralyzed muscles, becomes practically impossible of attainment if complete loss of elasticity and muscle tone has resulted from constant overstretching of paralyzed muscles by unopposed antagonists. A different but long recognized application of purposeful splinting is its employment so as to produce tension upon scar tissue for prolonged periods of time—particularly scar tissue that involves muscles, tendons and joint capsules. The subject of purposeful splinting can be presented to best advantage if the cases considered are grouped in accordance with the character of the injury and the anatomical structures chiefly involved.

#### I INJURIES AND INFECTIONS OF THE SOFT PARTS —SKIN, SUBCUTANEOUS TISSUE, MUSCLES, JOINT CAPSULES

The relief from pain that follows immobilization of injured soft tissues is well exemplified by the rapid improvement that follows splinting of the hand and wrist following a simple sprain. A patient falls on his outstretched hand, or he wrenches the wrist in

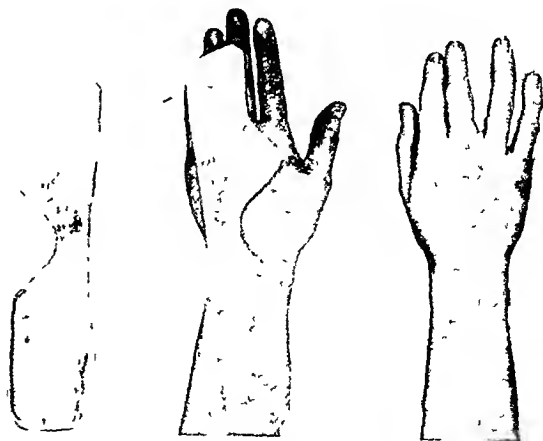


Fig 1 A simple aluminum splint to support little and ring fingers in extension and relax their extensor tendons. A crescentic piece is cut out on the radial side so as to eliminate pressure on the thenar eminence, the forearm portion is made concave so as to lie smoothly on the volar surface of the forearm.



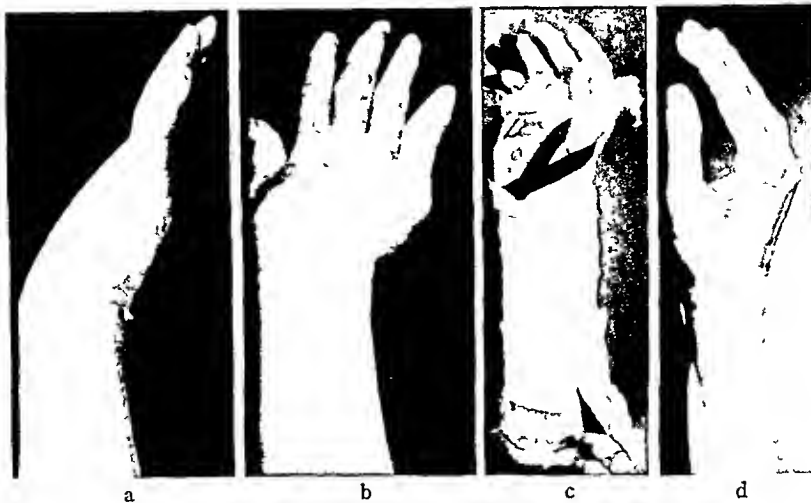


Fig 4 Result of physical therapy combined with splinting of the hand in the position of function in a case of neglected infection involving the radial and ulnar bursæ  
a, b, Appearance and position of hand at beginning of treatment c, Metal splint, similar in principle to that illustrated in Figure 3, with elastic band to abduct and rotate thumb d, Result at time wound discharge had ceased

ately adds to the patient's comfort and perhaps permits him the first relief from pain

If the inflammatory reaction associated with a spreading infection is added to the hemorrhage and tearing of tissue that result from injury, rest is even more important, and if it can be provided with the affected part in the position of function (Figs 3, 8), the ultimate result will be most satisfactory (Fig 4)

If contractures have developed as a result of neglected injuries or long continued infec-

tions, much can be accomplished by the use of splints which bring constant tension to bear upon scar tissue, whether it involves the superficial tissues, the muscles, the tendons, or the joint capsules The principle involved has long been accepted, and the use of tension in overcoming contractures, particularly of the von Volkmann type, advocated long ago by Claude Martin and his pupils in France and by Sir Robert Jones in England, has been the most important factor in the successful treat-



Fig 5 Glove fitted with buckles and straps to permit application of tension to fingers stiff in extension Tension can also be exerted upon the thumb if a buckle for the thumb strap is attached to the ulnar side of the glove at the level of the web

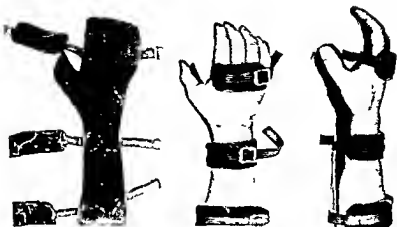


Fig 2 Padded aluminum splint to relax the abductors and extensors of the thumb and the extensors of fingers and wrist. It can be easily removed for cleansing of the hand and application of physical therapy and easily reapplied.

attempting to board a moving car, or he twists the fingers and thumb as he clutches at some support to keep himself from falling. The hand and wrist are painful and swollen, perhaps slightly discolored. Pressure over the ulnar side of the wrist joint or over the metacarpophalangeal joint of the thumb causes exquisite pain. Certain movements exaggerate the pain. X ray examination shows no evidence of chipped or of linear fractures. A sleeve of stockinet is drawn over the hand, and a plaster bandage is molded smoothly over volar surface of hand and forearm while the hand is held in the position of function—dorsiflexion

at the wrist, semiflexion of thumb and fingers, abduction of thumb from hand, palm facing the patient. The free ends of the stockinet are turned back to cover the upper and lower edges of the plaster splint. A muslin bandage is applied firmly and smoothly over the hardening plaster, and almost before the dressing is completed the patient expresses the relief he has obtained from the immobilization and the smooth pressure of the bandage.

A similar splint or one of light aluminum which immobilizes the hand with crushed fingers, or with lacerated wounds or with surface scalded by a flame or by boiling water immedi-

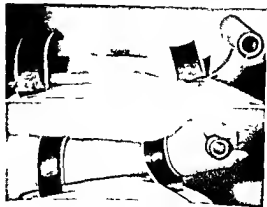
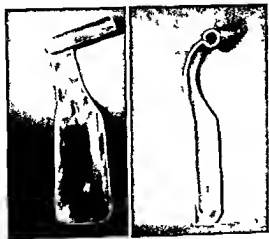


Fig 3 Splint for maintaining the hand in the position of function.

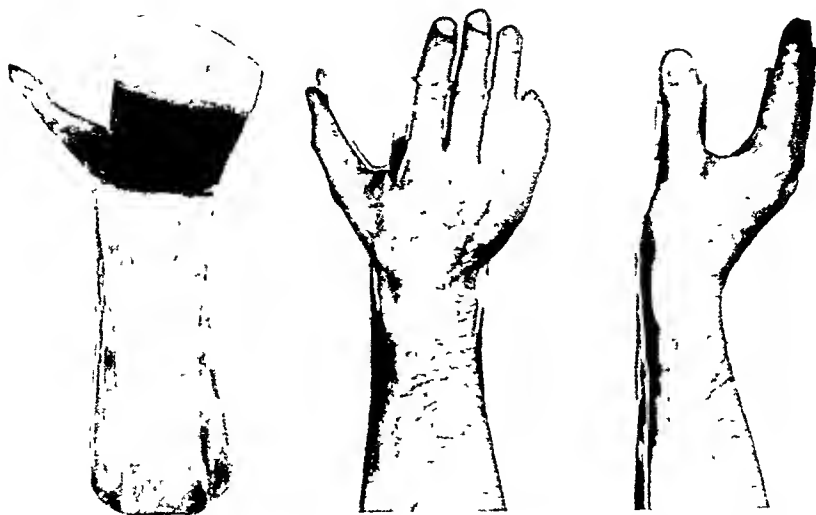


Fig 8 Splint for supporting fingers in extension and thumb in extension and abduction after suture of extensor tendons or injury of radial nerve By bending the distal end of the splint slightly to permit semiflexion of the fingers this splint serves equally well for maintaining the hand in the position of function

ber of cases in which open wounds of the dorsum of the hand have been followed by infection and sloughing of covering tissue and extensor tendons. By splinting the hand in dorsal flexion at the wrist and almost complete extension at metacarpophalangeal and interphalangeal joints, and by treating the open wound with cleanly surgical care, and in some cases with a skin graft of intermediate thickness, healing has been obtained in such cases and a bridge of scar tissue formed between the ends of widely separated tendons, which acted as a substitute for the extensor tendons and permitted the fingers and hand to be brought to a straight line when healing was complete. Although the fingers could not be maintained in complete extension when the hand was held in hyperextension at the wrist, the functional results were satisfactory and the necessity for technically difficult operative procedures avoided.<sup>1</sup>

If tendons have been sutured the part should be immobilized in such a position that mini-

mum tension is put upon the suture line. Otherwise one of several unfavorable results occurs: the suture material cuts through the tendon ends and fails to hold them in approximation, or the suture material gives way completely; or, at best, the fibroblastic and fibrous tissue which forms to unite the tendon ends is stretched to such a degree that the tendon is lengthened and the maximum contraction of the muscle belly is not sufficient to take up the slack.

If flexor tendons of thumb or fingers have been sutured relaxation is best obtained by flexion at wrist and metacarpophalangeal joints (Fig. 7). The fingers should not be sharply flexed at the interphalangeal joints. Flexing the fingers about a roller bandage in the palm after suture of their flexor tendons frequently results in fixation of the tendons within their digital sheaths and a contracture exceedingly difficult to overcome. After suture of extensor tendons relaxation of fingers or thumb can be obtained by dorsal flexion at the wrist and complete extension at metacarpophalangeal and proximal interphalangeal joints (Fig. 8).

### 3 NERVE INJURY

Sir Robert Jones in a lecture to a group of American medical officers once stated his be-

<sup>1</sup>If there has been loss of both covering tissue and tendons on the dorsum of the hand and healing takes place by scar tissue formation, one can not hope to unite the separated tendons or to replace the destroyed tendons with grafts without first securing a covering of normal skin and subcutaneous tissue to replace the destroyed covering tissue. The attempt to make an incision in scar tissue, dissect it from its bed to expose injured tendons, and then replace it and suture the incision will end in extensive sloughing and loss of tissue because of the low vitality of the scar tissue covering.





Fig. 6 Complete restoration of function of thumb resulting from simple splinting of thumb in abduction and extension for 4 weeks following division of extensor pollicis longus

ment of this condition. Purposeful splinting in the treatment of contractures involves the use of splints which permit the application of steady tension for prolonged periods of time, which do not produce excessive pain, and which can be easily adjusted and easily applied and removed so as to permit active use of the hand and the application of physical therapy in conjunction with the use of the splint. In cases in which the small joints of the hand have become stiff in extension the use of a glove fitted with straps and buckles, which permit the fingers to be drawn into a flexed position (Fig. 5), often is helpful.

## 2 DIVISION OF MUSCLES AND TENDONS

The retraction toward its origin and to a lesser extent toward its insertion that takes place the moment a muscle belly or its tendon

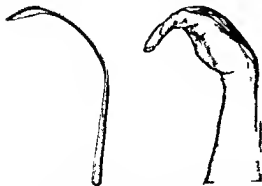


Fig. 7 Dorsal splint for securing relaxation of flexor tendons of fingers. The maximum flexion should be at wrist and metacarpophalangeal joints

is divided, is a well recognized fact. Released from their normal tension muscle fibers immediately contract to a position of rest. If the muscle or tendon is completely divided, and if the tendon glides in an individual sheath, as does the flexor pollicis longus for example, no amount of restraint or fixation of the affected part will prevent separation of the two ends or permit satisfactory healing without approximation by surgical operation. If, however, the muscle or tendon is not completely divided, or if its retraction is checked by bands or fibers of attachment to adjacent tendons, such as unite adjacent extensor tendons on the dorsum of the metacarpus or if it is fixed to some extent by areolar tissue such as surrounds the extensor pollicis longus on the dorsum of the thumb, immobilization of the part in a position that brings the insertion of the muscle as close as possible to its origin offers a reasonable chance that operation may be avoided. Such immobilization should be carried out in every case in which immediate operative treatment is contra indicated because of the conditions under which the wound has been sustained or because the most favorable time for operative care has passed before the patient is seen by the surgeon. Four times in recent years we have seen restoration of function of the completely divided extensor pollicis longus follow immobilization of the thumb in the completely extended position with the help of a splint applied 24 hours after injury and kept in place for a period of four weeks (Fig. 6).

Satisfactory though not completely successful, results have been obtained in a num

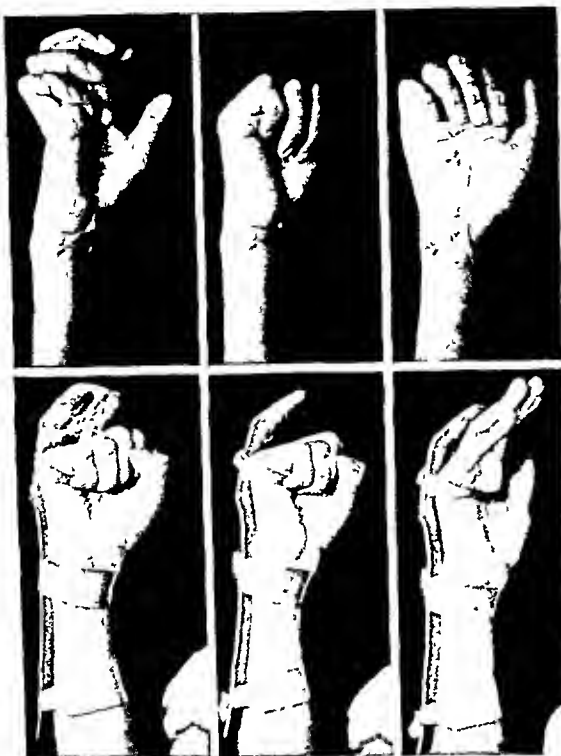


Fig 11 Splint for supporting fingers in semiflexion at metacarpophalangeal joints after suture of median and ulnar nerves. Strap shown in Figure 10 is attached to ulnar side of splint. Above, Appearance of hand 3 months after injury and repair of divided median and ulnar nerves and all flexor tendons. On attempting to straighten the fingers they fall into hyperextension at metacarpophalangeal joints because of lumbrical and interosseous paralysis. Below, Result 14 months after injury. Splint shown was worn constantly for 11 months to prevent overstretching of paralyzed muscles.

words, after suture of median and ulnar nerves just above the wrist the fingers must be supported in slight flexion at the metacarpophalangeal joints and the thumb in rotation and partial adduction during the period of from 9 to 15 months that is required for the slow downward growth of nerve axons. One patient recently under observation, a 12 year old boy operated upon a few hours after injury by Dr. Russell Bothe, then surgical resident at the Cook County Hospital, wore out the felt covering and leather straps on his splint three times during the course of a year, but the result obtained justified the trouble and inconvenience involved in the treatment (Fig. 11).

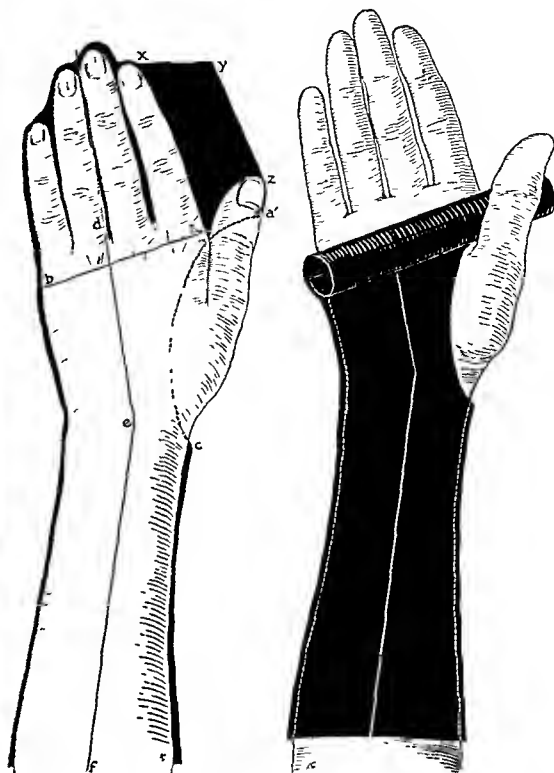


Fig 12 Pattern (in black) for making a simple splint to support hand in position of function. When at rest the longitudinal axis of the hand, *de*, makes a slight angle with the axis of the forearm, *ef*. The line of the metacarpophalangeal joints, *ba*, is not quite transverse to the long axis of the hand, and makes a still greater angle with the long axis of the forearm.

When the splint is cut along the line *a'e*, and the flat sheet distal to the line *ba* rolled into a small cylinder the splint lies smoothly on hand and forearm without pressure on thenar area. A few blows of the hammer are needed to gutter the part over the forearm and a slight bend in dorsal flexion at the wrist.

If the radial nerve is divided above the origin of its motor branches the paralyzed extensors and abductors must be supported in the relaxed position. Such a position involves abduction as well as extension of the thumb (Fig. 8). Simply to support the fingers and thumb on a flat splint dorsiflexed at the wrist is to ignore the importance of abduction in the function of the thumb.

#### THE PREPARATION OF SPLINTS

Since the surgeon may be called upon at any moment to provide a splint for any one of many indications and for any size of right or

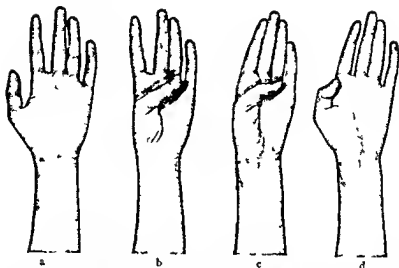


Fig. 9. Typical appearance of hand following division of median nerve and flexor pollicis longus: the atrophy of thenar eminence and inability to rotate the thumb to oppose the fingers are characteristic of median nerve injury. a b Before operation c d Degree of flexion at interphalangeal joint of thumb possible 3 weeks after operation

hief that if the hand and fingers were allowed to fall into complete flexion only once after a division of the radial nerve, an irreparable injury of the extensor muscles resulted. If a single overstretching of paralyzed muscle fibers causes irreparable injury, it is obvious how serious must be the effect of permitting paralyzed muscles to be continually overstretching by powerful and unopposed antagonists. The

typical deformity of the hand that results from the paralysis of the small muscles of the hand following injury or division of median and ulnar nerves is recognized by every medical student. Curiously enough though we take great pains to teach the student the meaning of the "ape hand," the flat and wasted thenar eminence (Fig. 9), the hyperextension at metacarpophalangeal joints, rarely is it emphasized that with adhesive strapping or a leather wristlet with suitable attachment it is possible to rotate the thumb to face the fingers (Fig. 10), or that with a simple and light splint the fingers can be supported in slight flexion at the metacarpophalangeal joints (Fig. 11) and the thumb adducted toward the hand and so paralyzed thenar muscles lumbrical and interosceus muscles and adductors of the thumb can be protected from the harmful effects of continued overstretching.

If the maximum value of such treatment is to be obtained for the patient it must be persisted in until functional restoration takes place. Sir Robert Jones expressed it tersely, "The most skilful operation performed on the most suitable case will prove a fiasco unless the affected muscles are continually kept relaxed until recovery takes place." In other

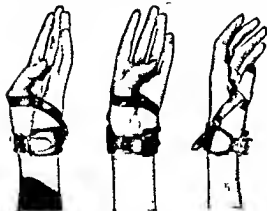


Fig. 10. Simple strap apparatus for rotating thumb so as to face fingers: the strap attached to the loop around the thumb is buckled to the wrist strap on the dorsum of the wrist

has more elaborate tools and metal cutting instruments at his command.

A few standard patterns serve as a basis for the great majority of splints required in ordinary surgical practice

1 *Volar cock-up splint* This splint (Fig 3) is designed primarily to support the hand in the position of function, dorsiflexion at the wrist, semiflexion at metacarpophalangeal joints and thumb abducted from the hand. Support of the hand in such a position during the long period of convalescence from a severe infection or an extensive burn greatly simplifies the problem of restoration of function when healing is complete. If used in the presence of acute infection the splint can be sterilized and incorporated in a large warm wet dressing. At a later stage it can be padded with soft rubber which can be easily cleansed and autoclaved if necessary. If used when little or no wound discharge is present it can be covered with felt and provided with straps and buckles to facilitate application and removal.

In making a pattern for the splint the normal hand of the patient is laid palm downward on a sheet of white paper and a tracing made of the hand and forearm (Fig 12). Three points are marked on the tracing *a*, the radial border of the hand at the level of the second metacarpophalangeal joint; *b*, the ulnar bor-



Fig 16 A splint to produce extension of semiflexed fingers and wrist with the aid of elastic tension

der of the hand at the level of the fifth metacarpophalangeal joint, *c*, the radial border of the forearm at the level of the radial styloid. An outer line, *xyz*, is added to give a rectangular shape to the distal end of the pattern. A crescentic section is cut from the pattern along the line *a'c* so as to eliminate pressure upon the thenar eminence. The rectangular portion of the splint distal to the line *aab* is rolled into a cylinder of small diameter in such a way that the long axis of the cylinder lies exactly parallel with the line *ab*. The cylinder should rest easily between thumb and fingers and permit

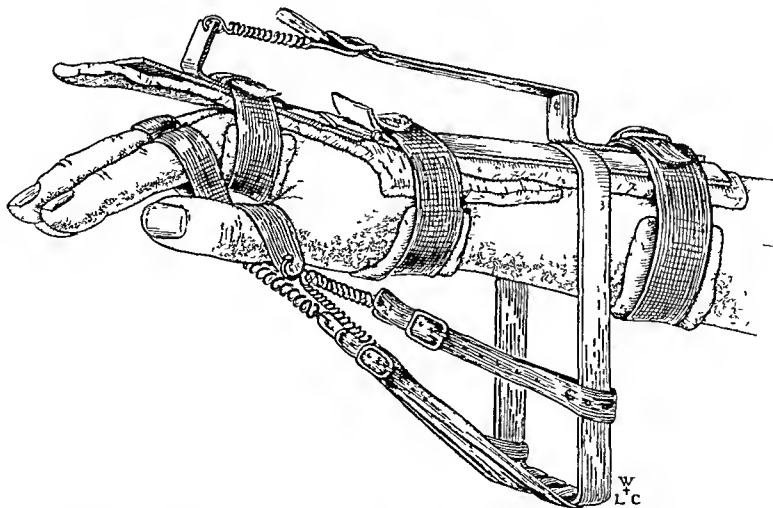


Fig 15 Splint for application of elastic tension to semiflexed fingers and thumb lying alongside hand

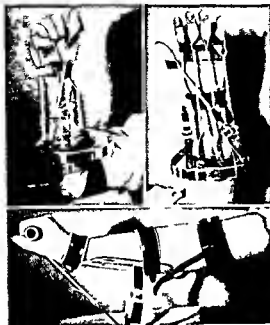


Fig 13 The same splint as in Figure 3 with cross bar straps buckles springs and loops for the production of elastic tension on fingers and thumb (In a left above and c below only one strap buckle spring and loop are shown so as to make the illustration clearer)

left hand he must have available adaptable material and means of fashioning it to the required end

For simple immobilization for a relatively brief period of an injured hand or forearm without an open wound nothing is more satisfactory than plaster of paris smoothly molded over closely fitting stockinet on dorsal or volar surface of the injured extremity Thumb or fingers can be included if necessary, or the splint stop short at any desired level to permit movement at certain joints

For most other purposes—for patients with open wounds, for tension splints, for splints requiring frequent removal and particularly for splints intended for use for long periods of time—aluminum has been found particularly useful and adaptable Sheet aluminum .064 inches in thickness, designated by the manufacturers No 2 S $\frac{1}{2}$ H, can be easily cut to the desired size with ordinary "tin snips" It is sufficiently rigid to maintain any desired shape, and still light enough not to be cumbersome With a few simple tools which can be kept in a drawer in the splint room—snips a hammer, a jig saw to cut finger pieces, bending irons, file and sandpaper to smooth rough edges, a small drill to bore holes, rivets with which to attach a thumb piece—and with a vise in which the splint can be firmly held as it is fashioned and smoothed off, splints for most purposes can be promptly and easily prepared For hinged splints and tension splints with slotted finger pieces we depend upon the splint maker who

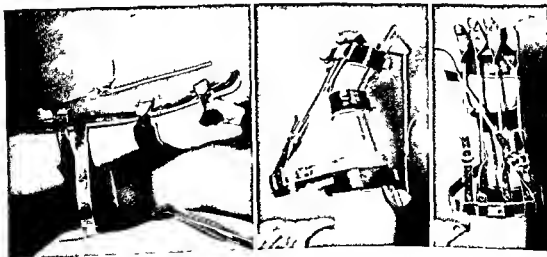


Fig 14 A splint designed to produce the same effect as that in Figure 13 but to be applied to the dorsum of the hand

has more elaborate tools and metal cutting instruments at his command.

A few standard patterns serve as a basis for the great majority of splints required in ordinary surgical practice

*I. Volar cock-up splint* This splint (Fig 3) is designed primarily to support the hand in the position of function. dorsiflexion at the wrist, semiflexion at metacarpophalangeal joints and thumb abducted from the hand. Support of the hand in such a position during the long period of convalescence from a severe infection or an extensive burn greatly simplifies the problem of restoration of function when healing is complete. If used in the presence of acute infection the splint can be sterilized and incorporated in a large warm wet dressing. At a later stage it can be padded with soft rubber which can be easily cleansed and autoclaved if necessary. If used when little or no wound discharge is present it can be covered with felt and provided with straps and buckles to facilitate application and removal.

In making a pattern for the splint the normal hand of the patient is laid palm downward on a sheet of white paper and a tracing made of the hand and forearm (Fig 12) Three points are marked on the tracing. *a*, the radial border of the hand at the level of the second metacarpophalangeal joint, *b*, the ulnar bor-



Fig 16 A splint to produce extension of semiflexed fingers and wrist with the aid of elastic tension

der of the hand at the level of the fifth metacarpophalangeal joint, *c*, the radial border of the forearm at the level of the radial styloid. An outer line, *xyz*, is added to give a rectangular shape to the distal end of the pattern. A crescentic section is cut from the pattern along the line *a'c* so as to eliminate pressure upon the thenar eminence. The rectangular portion of the splint distal to the line *aab* is rolled into a cylinder of small diameter in such a way that the long axis of the cylinder lies exactly parallel with the line *ab*. The cylinder should rest easily between thumb and fingers and permit

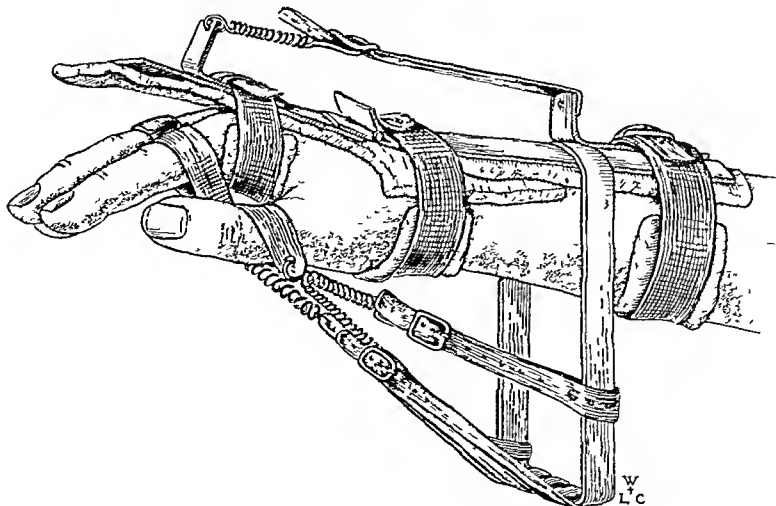


Fig 15 Splint for application of elastic tension to semiflexed fingers and thumb lying alongside hand

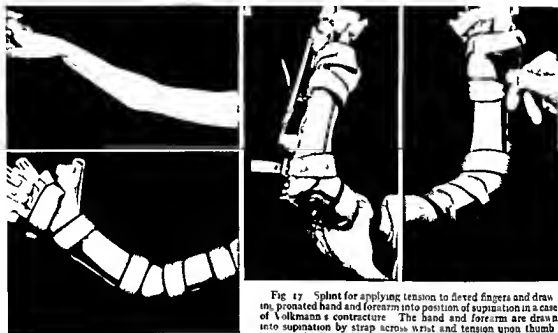


Fig 17 Splint for applying tension to flexed fingers and drawing pronated hand and forearm into position of supination in a case of Volkmann's contracture. The hand and forearm are drawn into supination by strap across wrist and tension upon thumb portion of splint to lower half of arm holds it in position.

flexion of the fingers at the metacarpophalangeal joints. Its long axis lies almost transverse to the vertical axis of the hand piece, *de*, and the latter forms a slight angle with the vertical axis of the forearm piece, *ef*. When the splint is guttered so as to lie smoothly on the forearm, and bent slightly at the wrist joint so as to provide dorsal flexion at the wrist joint, it should support the hand comfortably in the position of function (Fig 3, d).

**2 Splint for extension of fingers and thumb**  
If it is desired to hold the fingers and thumb in extension, for example, after suture of extensor tendon or injury of radial nerve, the splint is prepared from a pattern similarly made but the added portion, *xyz*, is omitted, and a thumb piece is added by riveting to the splint at the proper angle a single strip of aluminum, 1 inch wide and turned in such a way that the thumb rests easily upon it (Fig 8).

**3 Splint to apply tension upon fingers at metacarpophalangeal or interphalangeal joints**  
If it is desired to put tension upon stiff metacarpophalangeal or interphalangeal joints while the hand is held in dorsal flexion at the wrist joint a bridge or arch of aluminum can be riveted to the splint (Fig 13) and from it tension

applied to each digit. A loop to slip over each finger, and united to a corresponding loop on the bridge with a tension spring, a buckle and strap constitute a device easy to apply and remove, and easy to adjust to any degree of tension.

**4 Dorsal splint for application of tension upon fingers**  
If because of volar scars or open wounds it is found undesirable to place the splint on the volar surface of the forearm a similar effect can be obtained by making the splint in two pieces, one for forearm and one for hand, and uniting them with a hinge at the wrist joint. Dorsal flexion of the desired degree can be obtained by a stout spring strap and buckle running from the distal end of the hand piece to the forearm piece (Figs 14, 15). The pull on individual digits can be obtained by adding a bridge or arch, and straps and springs for individual digits just as with the volar cock up splint.

**5 Splint for application of tension on flexed fingers**  
The hinged dorsal splint can be used to advantage in cases of flexion contracture of the fingers whether the contracture is of the typical Volkmann type or whether it has followed infection or injury other than the typi-

cal injury about the elbow joint which leads to Volkmann's contracture. If the contracture is not too marked and the fingers can be partially extended a splint such as that illustrated in Figure 17 is useful. The thumb piece permits the application of tension to the thumb, the direction of the line of tension can be changed as desired, usually the thumb needs to be abducted from the hand so as to increase the span between thumb and index finger.

If the fingers are sharply flexed into the palm a splint which permits a pull directly distalward instead of dorsalward is required. Such a pull can be obtained with loops, springs and buckles attached to elongated finger pieces (Fig. 17) or by lengthening the slotted finger pieces shown in Figures 16 and 17 and bending them at a right angle near their distal ends.

Since this type of splint is usually required for advanced cases of Volkmann's contracture two other features are usually added to it. a thumb piece, extending outward from the splint opposite the base of the thumb, and a short arm piece, attached to the forearm piece by a hinge at the elbow, which serves both to keep the splint from being displaced distalward along the forearm, and so neutralizing the tension, and as a fulcrum from which tension in the direction of outward rotation of the forearm can be obtained (Fig. 17).

The latter is important in those cases in which the hand with sharply flexed fingers is constantly held in pronation. Unless it can be drawn into supination at the same time that the fingers are drawn into extension the result

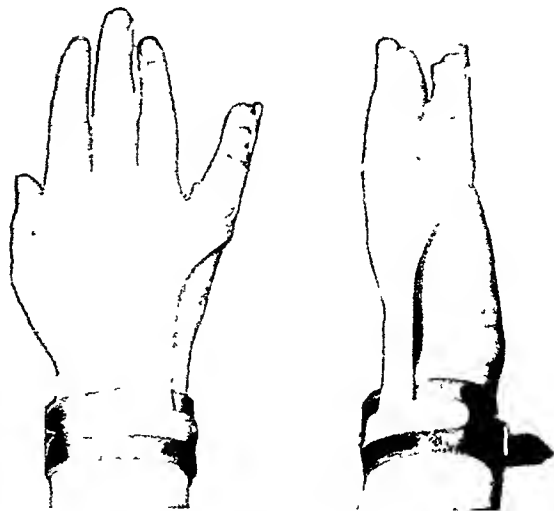


Fig. 18 Modification of Lewin's baseball finger splint for supporting a single finger in extension after suture of extensor tendons

will not be satisfactory. With the splint held in a fixed position with the aid of the arm piece the hand and forearm are drawn toward the position of supination with the help of a broad strap across the wrist joint and the outward pull upon the semiflexed thumb.

Other modifications of these splints will suggest themselves to anyone who is constantly confronted with the treatment of injuries of the hand. A single extension piece, for example, can be added to the volar cock-up splint and permit application of tension to a single digit while the others are supported in the position of function. For a fracture of a proxi-

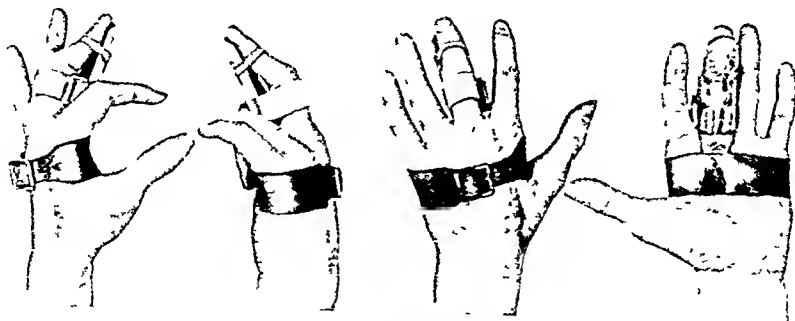


Fig. 19 Splint for applying tension upon a proximal interphalangeal joint left immobile in flexion after division of the extensor tendon. The proximal phalanx is drawn toward the splint by a circle of garter elastic.



mal phalanx, of a metacarpal, or for a Bennett's fracture of the metacarpal of the thumb such a splint is helpful. To support the fingers in abduction after separation of fused fingers and the application of a free graft a flat splint can be prepared with individual finger pieces widely separated. Such a splint gives support and immobilization and at the same time permits the application of sponge pressure over the grafts between the separated fingers. To support a single finger in complete extension a modification of Lewin's baseball finger splint is useful (Fig 18). To bring elastic tension to bear upon an interphalangeal joint after the finger has been left immobile in flexion following division of the extensor tendon a modification of Bunnell's safety pin splint (Fig 19) can be used to advantage.

It is hardly necessary to add that much effort and ingenuity have been expended by many men to devise satisfactory splints for immobilizing and protecting the injured hand. The cockup splint of Sir Robert Jones for supporting the hand in dorsiflexion at the wrist is known to every surgeon. The "baseball finger" splint of Lewin and the "safety pin" splint of Bunnell for producing extension at the proximal interphalangeal joint have been mentioned. William E. Browne's ingenious and adaptable splint can be utilized for many of the conditions referred to in the preceding pages.

#### SUMMARY

Purposeful splinting following injuries and infections of the hand involves at least three important principles: (1) securing rest for injured and inflamed tissues, whether soft tissues, tendons, muscles, joint capsules or bones, (2) securing relaxation of muscles whose ten-

dons have been divided or whose nerve supply has been injured, (3) bringing constant and prolonged tension to bear upon scar tissue whose gradual contraction interferes with the function of the hand. The studied application of these principles can aid very definitely in bringing about restoration of function after injury and infection have taken place.

#### REFERENCES TO THE LIFE OF THOMAS

1. ATKIN, D. McCRAE. Hugh Owen Thomas. His Principles and Practice. London: Oxford University Press, 1935.
2. FETTER, ARTHUR. Menders of the Maimed. Chap. 3. London: Henry Frowde, 1919.
3. McILLERAY, T. P. The life of Hugh Owen Thomas. Liverpool M. Chir. J. 1935, 43, 5-41.
4. THOMAS, H. O. Diseases of the Hip, Knee and Ankle Joints with Their Deformities Treated by a New and Efficient Method. 2d ed. Liverpool: T. Dobb & Co., 1856.
5. Idem. On past and present treatment of intestinal obstruction. Liverpool and Manchester M. & S. Rep. 18. Liverpool, 1858, 1-53.
6. Idem. On the treatment of fractures of the lower jaw. Lancet, Lond. 1867, 1, 79.
7. MATSO, FREDERICK. Hugh Owen Thomas: A Personal Study. London: Oxford University Press, 1934.
8. Idem. The Life of Sir Robert Jones. Baltimore: William Wood & Co., 1935.

#### REFERENCES TO THE USE OF SPLINTS

1. BROWNE, W. E. The necessity for use of plasters at certain stages in the treatment of infections of the hand with a demonstration of some of the newer types. New England J. Med. 1936, 15, 143-148.
2. BLANELL, STERLING. Reconstructive surgery of the hand. Surg. Gynec. & Obst. 1934, 49, 259-274.
3. JONES, SIR ROBERT. Notes on military orthopaedics. II. On suture of nerves and alternative methods of treatment by transplantation of tendon. Brit. M. J. 1916, 1, 611.
4. Idem. Address on Volkmann's ischaemic contracture with special reference to treatment. Brit. M. J. 1928, 2, 630-642.
5. LEWIN, PHILIP. A simple splint for baseball finger. J. Am. M. Ass. 1925, 45, 1039.
6. MARTIN, CLAUDE. Bull. de la Soc. de chir. de Lyon, 1902-03.

# FLUID BALANCE IN THE PUERPERIUM

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THE more we add details to the sum of knowledge about any common disease when it occurs in patients who are in, or immediately past, the period of gestation, the more it appears that pregnancy distorts the picture from that presented in the non-pregnant. This conviction and noted instances of undoubted polyuria after delivery have supplied for me the impetus to investigate fluid balance in the puerperium as a distinct entity. I am conscious of the fact that the methods employed in obtaining these data fall far short of scientific requirements in completeness, a complete study is more fittingly performed in a well equipped laboratory and then on comparatively few patients. It may not be wasted effort if, from a more gross demonstration of the essential findings in a larger group of cases, intensive study of a smaller group may be stimulated and carried out under proper laboratory conditions.

In the beginning I wish to present a group of hitherto unassociated observations which indicate first, that the pregnant woman fails to eliminate fluids as adequately as does the non-pregnant woman, and second, that the storage of fluids in the blood stream and tissues of the body in the course of a normal pregnancy may, and probably does, without production of anasarca, take place elsewhere in the body besides in the obvious place for fluid increase, that is, in the products of pregnancy.

These observations fall under three headings

- 1 Evidence of increased fluid content of the blood
- 2 Evidence of retardation in the mechanism of conducting secreted urine away from the secreting unit, the renal cortex
- 3 Functional tests, in so far as they have yet been applied to pregnant women, paradoxically indicate decreased functional activ-

ity without evidence of storage of waste products of metabolism in the blood stream

Whatever may be the etiology of the storage of fluids in pregnancy, if it exists, the wisdom of such provision is obvious. At delivery, there occurs a sudden and excessive drain upon body fluids which is immediately followed by further encroachments during the immediate postpartum period. Within a very short time, the patient eliminates from her body the products of her pregnancy, accompanied by the loss of blood and excessive radiated fluids attendant upon her exertions. The fluid losses at delivery may be enumerated as amniotic fluid, fluid content of the baby, blood and fluid content of the placenta, blood loss of the mother, and excessive lung and skin radiation. The ensuing postdelivery losses within the 14 day convalescence covered in this study are lochia, some of which is included inadvertently in the urine and the remainder caught in pads, and mammary gland secretions. Loss of fluid through these two factors, while not measured or allowed to enter into this problem, are considerable. The "milk department" of the Boston Lying-In Hospital states that during the first postpartum days, average secretion from the mammary glands is 15 ounces but that it soon rises to 32 to 40 ounces with peak output for individual patients as high as 64 ounces each 24 hour period.

In the studies here recorded, no consideration is given to the fluid loss at delivery or to the lochial and milk loss during the puerperium. The record comprises only the liquid food and water intake to determine the intake curve, and the urinary excretion with whatever lochia may accidentally be included, to determine the output curve. The period covered begins immediately upon delivery but does not include urine removed by catheter during delivery and continues to the end of 14 days, at which time patients are normally discharged from the hospital. Wherever unavoidable loss of urine has been encountered,

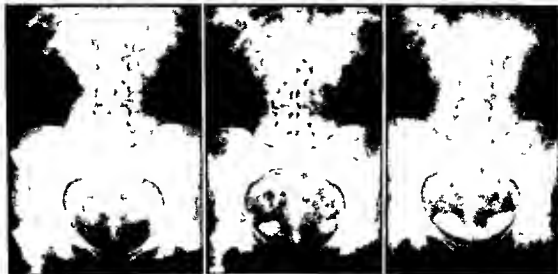


FIG. 1. Roentgenogram of patient aged 24 years. Complaint fatigue pain in left hip. Excretion periods 5, 15, 25 and 40 minutes. The accuracy of calyceal delineation is best on left at 5 minutes, on right at 15 minutes. Beginning emptying, on both sides at 25 minutes.



the graphs are so marked. Credit should here be given to the nurses of the Boston Lying In Hospital, who, under the direction of Miss Garran, showed both painstaking attention to detail and ingenuity in obtaining accurate records.

One may more readily accept the obvious premise that there is abundant need for excess fluid in the body of a woman who is about to undergo delivery than prove its presence. A few women because of extensive edema can safely be assumed to have excess fluid. These

cases are not the rule, however, and most pregnant women cannot be considered edematous. While one may assume that uterine pressure causes vulval and leg swelling, edema is not proved to show predilection for the primiparous patients in whom inelastic abdominal walls form a tight fitting uterus. And in cases in which small amounts of local edema occur, as seems to be the case in about three fourths of pregnant women, it is almost as apt to be in the abdominal wall above the point of pressure against the great vessels of the pelvis as in the lower extremities. There is however, a peculiar softness to the tissues in pregnancy that imply fluid excess although demonstrable edema may be entirely absent. In the Boston Lying In Hospital an energetic cardiac clinic promptly labels circulatory deficiencies. In the patients studied the cardiac cases are noted and their classification given.

During the period covered in this study no attempt was made to segregate types of cases. It seemed wiser that all types should be included irrespective of their clinical complications in order that a cross section of obstetrical cases might be obtained. The result was that the whole hospital population was put on



Fig 2 Roentgenogram of primipara, unit history No 23,052. Complaint transitory albuminuria. Study case, 2½ months pregnant, uninfected. Excretion periods 5, 15, and 30 minutes. Best plate 15 minutes.

measure and record charts. For this reason there are only small numbers of each of the groups except the normal deliveries. In most instances the number in each subdivision is too small to justify deductions from them except in comparison with the whole group.

In this communication the probability of excess fluid in pregnant women is established by deduction from present known facts concerning pregnancy. The study demonstrates that in 55 cases, with the exception of 5 in which, owing to rapid increase of fluid intake because of infection, output lagged behind intake beyond the 14 day period, there was but one instance in which there was not a readjustment of fluid balance during the puerperium in which the output of urine exceeded the intake of fluid by a total of from 3 ounces to 214 ounces extending over a period of from 1 to 8 days. I shall therefore assume that this phenomenon implies an excess of body fluids which may be capable of withstanding the fluid losses of delivery, lochial loss during the postpartum, and lactation during the 14 day study period, and still show the need for readjustment, if the normal situation of intake exceeding output by the amount of the normal body fluid losses through respiration, skin

radiation, fecal fluid content, etc., is to be reapproached.

In estimation of the etiology of fluid storage in pregnant women, one turns immediately to the well known renal dilatations of pregnancy which are now recognized as being almost universally present. They undoubtedly vary both in time of appearance and in extent. This may be so because of variable mechanical pressure factors in which the uterus obstructs the ureters to varying degrees. Pressure alone now seems inadequate to explain pelvic and ureteral changes in pregnancy. The modified endocrine state in pregnancy must be added to pressure to explain the renal changes in the gravid state. The degree of endocrine variation may not be any more constant than pressure mechanics either in one individual at various periods or among individuals. I know of no data from which I can assume that the effect of the pregnancy hormonal state is to produce impaired secretive action in the renal substance. In fact, intravenous urography indicates prompt secretion of the media into the calyces. I believe that until more data are collected from studies of endocrine effect on organs, we are justified in assuming that muscular atony of

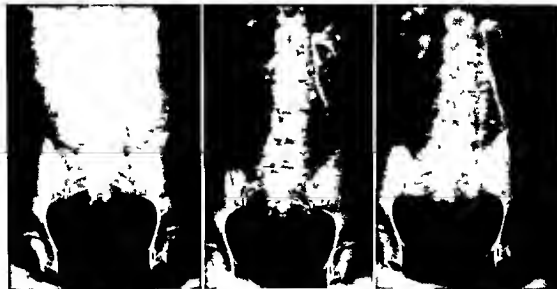


Fig. 3. Koenigsmannogram of primipara, unit history No. 18191. Complaint: acidosis and vomiting. Pyelography at 6 months, uninfected. Excretion periods 5, 15, and 45 minutes. Best plate 45 minutes. Dye appears in calyces of both kidneys at 5 minutes. Dense concentration of dye in calyx on right and in calyx, pelvis and ureter on left at 15 minutes. At 45 minutes right ureter only dimly outlined, left ureter excellently outlined.

the conduction apparatus is the factor concerned. Failure to remove secreted fluids from the secreting unit may impair fluid clearance from the kidneys, as prostatic obstruction of the bladder seems to be followed by polyuria when constant drainage is established.

I am prepared to accept a double etiology for these renal changes which take place in pregnant women. They seem to me to be capable of playing the major rôle among significant factors favoring storage of fluids during pregnancy. They are first relaxation of the musculature of calyces, pelvis and ureters as a manifestation of a changed endocrine state in pregnant women, and second pressure of the abdominal wall as well as gravity, which tends to force the inverted cone shaped uterus into the inelastic bony pelvis, across the brim of which the ureters pass in an exposed position, the right one more so than the left. It is not now possible to dissociate these two factors in importance in estimating roentgenographic appearances and physiological behavior of the changed renal tree. The evidence now available seems to indicate that endocrine changes are at least of equal im-

portance with pressure in producing this phenomenon. Both in pregnant women and in pregnant quadrupeds, when the pressure factor can be almost if not completely eliminated, evidence has been produced in the several investigations which I shall mention to indicate that atonic relaxation of the renal tree begins almost immediately in pregnancy, and that it antedates the presence of sufficient uterine enlargement to produce pressure against the ureters.

I do not doubt that pressure accentuates pelvic and ureteral changes in women over quadrupeds. It also is the only acceptable explanation to date of unequal degree modification of the right renal tree over the left in pregnant women. Renal changes seem to begin quite early in the latter and to become progressive in degree throughout the greater part of pregnancy. Pressure changes appear to be mechanically possible only from shortly before mid pregnancy on to term, yet in most of the several researches noted there appears to be partial relief from renal embarrassment in the latter weeks of pregnancy without improvement in the mechanical set up which

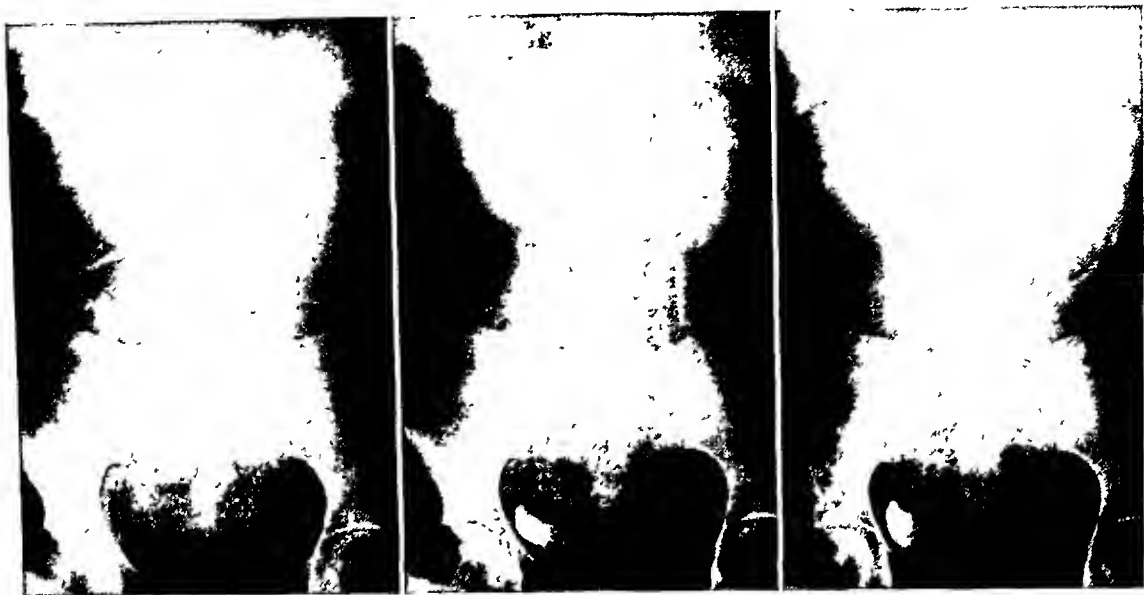


Fig 4. Roentgenogram of primipara, unit history No 23,234 Pyelography at 6 months Complaint right renal distress Excretion periods 5, 15, and 40 minutes Only calyces fill at 5 minutes At 15 minutes right calyx dense, left pelvis and ureter dimly outlined At 40 minutes, right ureter not yet filled, left pelvis and ureter clearly outlined

makes pressure against the ureters possible Those changes in the behavior of the renal tree in regard to secretion and clearance of urine, which antedate a mechanical set up that can conceivably bring pressure to bear against the ureters, must be attributed to some other factor

Rowntree, in a summation of known facts regarding water balance (1922), states that the endocrine system unquestionably plays a part in the control of this balance and that polyuria follows extirpation of the posterior lobe of the pituitary body Further work in succeeding years has indicated a fluid balance disturbance during the catamenia and that the pituitary body participates in the changed endocrine state of pregnancy and the puerperium

I have assembled 7 observations, most of them from dissociated sources, all of which seem to me to be trustworthy In these there is a striking uniformity in findings The changes which are discussed appear uniformly to assert themselves in the first trimester of pregnancy, reach a peak of effectiveness in mid-pregnancy, and most of them show an upward trend beginning about the

eighth month of pregnancy These observations collectively, as well as each in its own right, seem to indicate the probability that fluids are stored in the body of the pregnant woman in the course of her 9 months' gestation

The first of these citations has to do with dilution anemia (Minot, Straus, Castle, Rowland, Wills, Talpade, 2) Briefly stated, the normal blood picture of the non-pregnant changes during the first 4 months from a hemoglobin reading of 80 to 85+ per cent and a red cell count of 4,000,000 to 4,500,000, to a hemoglobin reading of 60 to 70 per cent and a red cell count of 3,000,000 to 3,500,000, with definite evidence of improvement in both hemoglobin and cell count beginning at the eighth month of gestation This variation is due entirely to increase in plasma The cells are normal in number and character The condition is not improved by liver, iron, or other therapeutic measures In other words, there is a normal cell constitution but an excess of the fluid content of the blood

The second item of evidence is provided by animal experimentation Rossi has recorded his observations on the effect of preg-

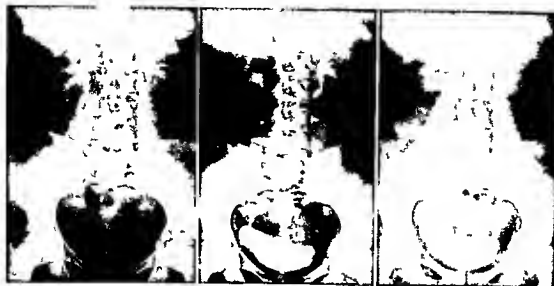


Fig 5 Same case as Figure 4. Two months postpartum. Excretion periods 5, 15 and 30 minutes. Best delineation of pelvis, calyces and ureters at 5 minutes.

nancy in rabbits on the time after injection of intravenous pyelography media at which x ray evidence of the greatest concentration of dye is obtained. In non pregnant dehydrated rabbits, the best plates are obtained in from 3 to 5 minutes after injection of the media. In rabbits in the twentieth to twenty fifth day of pregnancy, the best plates are obtained from 15 to 20 minutes after injection. Abramson, Robins, and I are now engaged in repeating this experiment, and we believe Rossi to be correct. These observations might be interpreted to indicate that there is reluctance on the part of the kidneys of the pregnant rabbit to give up the dye as promptly as in the non pregnant. This might be construed as indicative of deficiency in the renal cortex were it not that the calyces of the kidneys appear to fill as readily in pregnant as in non pregnant animals. The defects in the earlier plates in pregnancy seem to be due to failure of the media to become distributed throughout the pelvis and ureter.

The third item of evidence is that which my collaborators and I have produced and which concerns a similar delay in appearance of the 'best film' in the pregnant human as compared with the normal woman of similar

age group. It is generally agreed among radiologists and urologists that in non pregnant normal individuals the best roentgenographic demonstrations are obtained soon after injection of the intravenous media. The 5 minute plate is most often the best, the 10 minute plate next in frequency and rarely the 15 minute plate shows to best advantage (Fig 1). In a survey of 253 pyelographies in pregnant women (1) the best plate in mid pregnancy is most often obtained at 30 minutes after injection of the media. As early as 2½ months in pregnancy (Fig 2) the 5 minute and 10 minute plates are oftener inferior to the 15 minute plates.

In a more advanced pregnancy (fifth to eighth month) there is a tendency to fill the calyces early, but there is noted a definite lag in distribution of the dye throughout the pelvis and ureter (Fig 3). In the more marked stages of dilatation of the pelvis and ureter adequate delineation of the pelvic and ureteral outlines is not obtained until after 45 minutes (Fig 4). But soon after the termination of pregnancy, the kidneys return to their normal excretion rate (Fig 5). In extensively changed large lesions adequate outlining of the pelvis and ureter are not obtained until

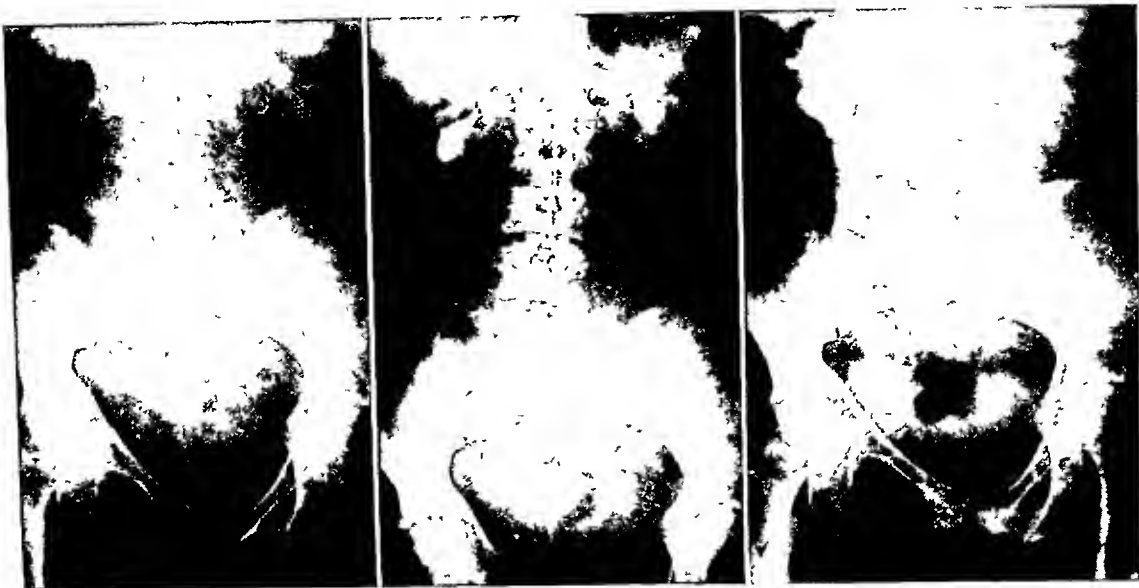


Fig 6 Roentgenogram of tripara, unit history No 4,343 Pyelogram made at 6 months Complaint bilateral pyelitis of pregnancy Excretion intervals 5, 15, and 45 minutes Abnormal kidney right, greater dilatation on left Calyces fill both sides at 5 minutes Ureters first show both sides at 45 minutes

from 45 to 90 minutes (Fig. 6) In infected cases, the calyces may not fill at all

The fourth item of evidence is drawn from the study of the ability of pregnant women to eliminate a peak load of fluid This evidence is produced by Janney and Walker The conditions of their experiment were aimed at the determination of what percentage of an enormous intake of water would be excreted in a 30 minute period in normal women as controls and in women in the different weeks of pregnancy They concluded that for normal women, intake and output volumes were identical In pregnant women, there is a marked and progressive decrease in the ability of the kidneys to handle peak loads of fluid, which reached its lowest figure in mid-pregnancy but which showed a slight upward trend in the latter portion of pregnancy

The fifth item is supplied by studies of motility of the pelvis and ureter by the hydrophoragraph Traut, McLane, and Kuder produced evidence to indicate that beginning early in pregnancy, there is a progressive decrease in motility of the pelvis and ureter which reaches its lowest level in mid-pregnancy and shows an upward trend at the eighth month

The sixth item of evidence produced is that of the clinical and experimental data concerning the curve of degree of dilatation noted in the months of pregnancy Traut, McLane, and Kuder record in a reversed curve the degree of dilatation of pelvis and ureters in contrast to the curve of motility of the musculature This curve has its peak in mid-pregnancy and declines steadily toward the end of pregnancy

The pyelography available for study at the Boston Lying-In Hospital, where ever repeated pyelography has been done, confirms this point of view From purely clinical observations both incidence of pyelitis symptoms and severity of symptoms and signs occur in mid-pregnancy It is only in the occasional case that pyelitis symptoms begin after the eighth month or are severe if they do occur

The seventh item in support of a changed renal behavior is that supplied by laboratory data Excretion of dyes from the kidneys as indicated by phthalein excretion or similar drugs is below normal Sondern and Harvey first showed (1911-1912) by intramuscular injection of phenolsulfonphthalein in 18 nor-



TABLE I—COMPOSITE CHART OF DATA ON THE TOTAL 55 CASES

Case No.	D y													Total excess ounces	No of d ys	
	1	2	3	4	5	6	7	8	9	10	11	12	13			
1				2	14		9	23	19	2				107	6	All b fluids
2				5			11	9		15	10			84	5	
3	17		25	45	52	56	125		17					114	7	
4		6			58				5					40	3	
5				9		16	9	0	27					67	5	
6					8			5	16					19	3	
7				10	15			10	8					54	4	
8					8									8	1	
9	2		7	11	10	15								50	3	
10				16	12		4	2						54	4	
11		17	15	6		3		4						47	5	
12		15	11		18									51	3	
13				23	11									40	1	
14			43	1	11	11		9						130	3	
15			5	15	14	7	10	7						98	6	
16		2	13	6	15	11	17	15	6					111	8	
17		14			14		3							70	4	
18			10	10	3					2				74	4	
19		15	11					5					4	60	4	
20		1	9	10		3								4	4	
21						16	12	11						61	4	Forced fluids
22	I sub	h	nt	D	ta											
23		10						3	5					61	3	
24		6												5		
25					10	3	10							55	3	
26			9	13	13		1	10						80	3	
27		3	16	15	1		5							62	5	
28				1		6								7		
29	None													0	0	
30		4						8						12		Pre-emptive
31		11	5	1	41	17	10	15		1				7	8	
32		10						3						5		
33														1	1	
34		8												8		
35		7	4	10	3	40								10	5	
36		0	1			45								11	3	
37			10	10	44	10	9		16	15				117	1	
38				1		11										
39	None													0	0	Infect with red fluid
40			11		10									61		
41	None													0	0	
42	None													0	0	
43	None													0	0	
44	None													0	0	
45	None													0	0	
46	None													0	0	
47	None													0	0	
48	None													0	0	

TABLE I—Continued

Case No	Day													Total excess ounces	No of days	
	1	2	3	4	5	6	7	8	9	10	11	12	13			
45	None													None	None	Gonococcus endocervicitis
46					23	5								28	2	
47									1				14	15	2	
48			4	21	18	13								56	4	Retention of urine
49		33	18	22	43	21		42						170	6	
50					1	24			4					20	3	
51		18	21	30	21	32	26	11						150	7	Cardiacs
52			17	5	10		9	14		7				62	6	
53	13													13	1	Postpartum hemorrhage
54		19		12		12					12			55	4	
55				5				10						15	2	

mal women late in pregnancy that there was in all a delayed appearance time for the dye from 8 minutes in the non-pregnant to 12 minutes in the pregnant women, and a total output in 2 hours of 45 per cent instead of 75 per cent average for 18 normal non-pregnant women. There were 3 cases among the 18 in which dye excretion was greatly depressed. Yet over a period of several years' observation, non-protein nitrogen tests are noted in the Boston Lying-In Hospital to range in the low normals, as do creatinines and other tests devised to indicate storage of waste products of metabolism. It seems logical to look upon this episode in dye behavior as similar to the excretion of intravenous pyelography media. In the latter, visualization of the pyelography media gives the clue to the failure of the dye to appear in the bladder promptly or in normal quantities. If the phenolsulfonphthalein and the dye are promptly excreted through the whole glomerular and tubular units, although delayed in reaching the outer world, there is no reason why there should be retention of waste products in the blood. It has not been demonstrated that there is appreciable re-absorption of fluids or urine salts from the mucous membrane lined conducting channels of the urinary tract. Only their removal from the body after passing through the secreting unit is delayed.

Analysis of these data indicates that there is evidence of increase in blood plasma in pregnancy. Edema stands as a further manifesta-

tion of excess body fluid during pregnancy in a few

There is a decreased ability to handle peak loads of fluids in pregnancy in normal women.

Pregnancy itself in animals (quadrupeds) and pregnancy alone but accentuated by uterine pressure does not appear to impair the excreting ability of the kidney, but impairs, through delay, the clearing of excreted urine from the renal tree.

It is therefore logical to expect storage of fluids during pregnancy and a re-adjustment in fluid balance soon after delivery.

In support of this hypothesis I have noted clinically isolated cases which indicated that there was excess excretion over intake immediately following delivery. In some instances an immense residue was found in the bladder so near to delivery, at which time the bladder had been emptied by catheter, that it seemed impossible that a sleeping patient could have taken that amount of fluid in that period of time. In one specific case, a total fluid intake of 3,765 cubic centimeters had been accompanied by an output of urine of 4,920 cubic centimeters, yet catheter revealed 1,890 cubic centimeters bladder residue in addition.

The duration of this experiment to determine fluid balance in the puerperium was terminated spontaneously by the limit of the ability of the nursing staff of the hospital to carry so accurate a recording of intake and output further. It resulted in the assembling of complete charts on 55 cases. By reference

TABLE I.—COMPOSITE CHART OF DATA ON THE TOTAL 55 CASES

Case No.	D y													Total excess ounce	No of days	
	1	2	3	4	5	6	7	8	9	10	11	12	13			
1				26	14		20	23	0	2				107	6	All b fl ds
2				3			12	10		25	10			84	5	
3	17		25	45	3	56	18		17					214	7	
4		6			38									40	3	
5				0		30	0	10	27					61	5	
6					8			5	6					20	3	
7				12	6			10	5					54	4	
8					8									8	1	
9	2		7	11	10	15								50	5	
10				15	3		4	2						54	4	
11		17	15	6		5		4						47	3	
12		35	11		8									81	3	
13				23	17									4	1	
14			45	1	31	3		10						130	5	
15			15	13	34	7	20	7						95	6	
16		8	23	6	35	33	17	18	6					150	8	
17		14		11	14		37							7	4	
18			20	20	3					20				74	4	
19		3	34					25					4	60	4	
20		1	9	30		7								4	4	
21						10	13	3				1		92	4	
22	In	Percent	Data													
23		0						23	5					63	3	
24		0		1										13		
25					40	3	10							55	3	
26			9	13	15		1	13						80	5	
27		3	16	19	1		5							65	5	
28				1		6								7	1	
29	\							8						\	no	
30		4												12	2	
31		5	3	3	4	37	46	25		2				201	9	
32							1							51		
33		30						3						1		
34		8												8	1	
35		7	4	10	3	46								10	5	
36		20	18			45								81	3	
37			0	5	44	3	0		6	18				77	7	
38				11		11								7	2	
39	\	c												No	\	
40			51		1									61	2	
41	\													\	No	
42	\													\	c n	
43	\													0	1	
44	\													None	\	
45	\													None	\	
46	\													None	\	
47	\													None	\	
48	\													None	\	
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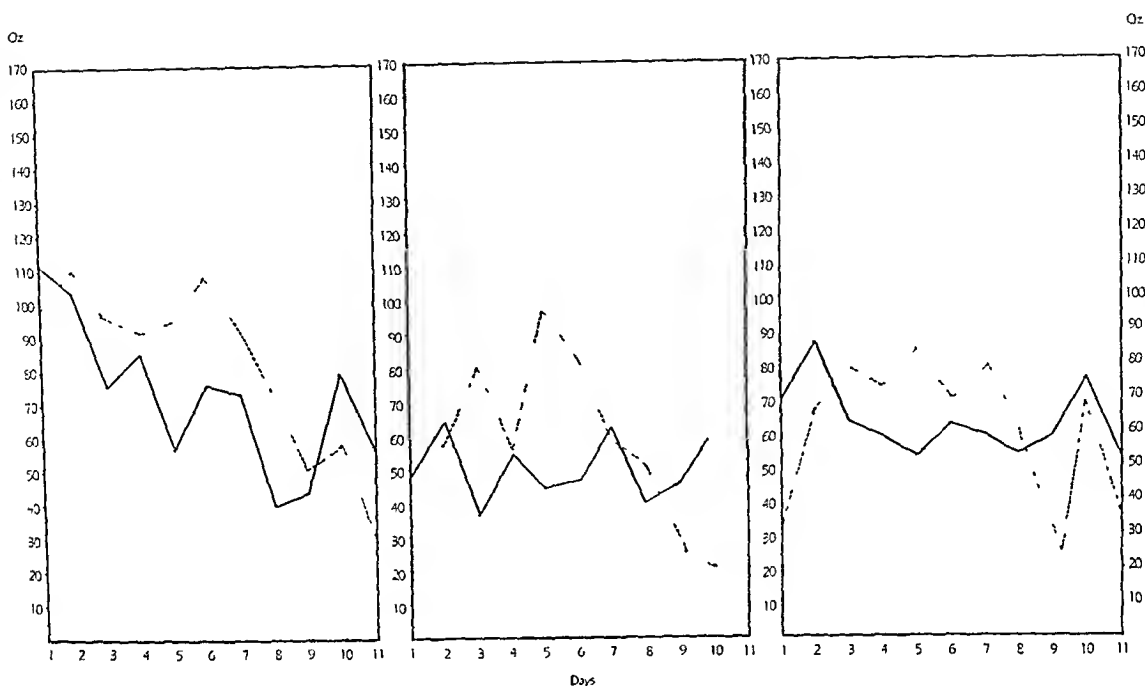


Fig 7 Charts of 3 typical cases showing fluid balance of patients which emerge from delivery on fluids ad lib M A secundipara, upper respiratory infection, afebrile S B, secundipara, afebrile E E, primipara, afebrile  
—intake,      - - - - - output

but that the third, fourth, fifth, and sixth days show greater frequency of excess and greater amounts of excess

Total excretion of fluid in excess of intake was but 13 times under 30 ounces. Nine times it exceeded 100 ounces, and twice exceeded 200 ounces.

Reference to Table I reveals that it makes little difference in the number of days of excess secretion as to whether the patients emerge from delivery on ad lib fluids or on forced fluids. The figures are 4.0 days for the former and 4.3 days for the latter. There is, however, a larger amount of fluid handled. The average total excess excretion for the ad lib group is 68.3 ounces and for the forced fluid group 114.8 ounces.

In 2 other groups there might be factors outside those prevalent in normal pregnancy which might influence the relation of intake and output curves. Both groups are small, they are the pre-eclamptics and the cardiacs, 5 of the former and 3 of the latter. The endocrine state is definitely variant from that in

normal pregnancy in the eclamptics. In spite of this variation the total excess fluid exceeded 83 ounces in 3 of the 5, and exceeded 100 ounces in 2 of the 5.

The cardiacs might be considered as more likely to store fluids because of impaired circulation. They were also kept on greatly restricted intake of fluid. In spite of the latter, they were above the average in total fluids excreted, and excreted an excess for a greater number of days with an average for the 3 cases of 5.3 days.

I question whether it is possible so to restrict fluids in afebrile conditions in pregnancy that there is not produced a fluid storage in the course of the pregnancy, which is adequate to meet the fluid losses attendant upon delivery and the establishment of lactation in the puerperium if fluids are not curtailed up to the limits of deprivation.

A better graphic image of the nature of the disturbed fluid balance in the puerperium can be obtained by reference to the individual charts which are appended (Figs 7, 8, 9).

TABLE II—DISTRIBUTION OF DAYS OF EXCESS FLUID AFTER DELIVERY

	1	2	3	4	5	6	7	8	9	10	11	12	13	None
Ad lib fluids	2	3	4	5	10	4	3	7	5	2	1	0	0	
Forced fluids	0	10	9	12	5	8	9	10	2	3	0	1	1	
Pre-eclampsies	0	3	3	3	2	4	3	0	1	1	0	0	0	
Cardiacs	0	1	2	2	3	2	2		1	1	0	0	0	
Total of all cases	3	16	21	20	25	27	27	23	11	6	2	1		

	Days of excess fluid	Average excess fluid (14 days)
Ad lib fluids	40	68.3
Forced fluids	43	111.8
Pre-eclampsies	36	81.5
Cardiacs	53	83.3
Total of all cases	112	77.6

to Table I it will be noted that the cases studied consisted of

13 cases of normal delivery in normal uninfected women who had taken fluids as desired without any effort at forced fluids. Fluid range per 24 hour period was 70 to 100 ounces

19 cases which emerged from delivery on forced fluids with a range of intake above 100 ounces

5 pre eclamptic cases, some of which had been dehydrated, others were taking fluids ad lib

4 infection cases with onset of infection soon after delivery. Fluids were gradually and steadily forced until the intake rose to 150 ounces or above

2 urinary tract infection cases which were on forced fluids similar to group No. 4

3 gonococcus endocervicitis cases in which fluids were ad lib

2 cases of retention of urine which were treated for but a few days by catheterization. Fluids ad lib

3 cardiac cases in which restricted fluids with intake between 40 and 70 ounces per day had been the routine

3 cases in which postpartum hemorrhage had occurred. Forced fluid was instituted and transfusion employed

In 1 case the data were insufficient for determining the fluid relation

In the whole group there were but 6 instances in which, for a period of from 1 to 5 days, there was not some time during which the intake of fluid was not exceeded by the output of urine. This phenomenon occurred even though the record of all other fluid losses attendant upon delivery and lactation were not included. This observation would in itself establish as a fact the presence of a definite fluid readjustment which regularly fol-

lows pregnancy and delivery. The figure is further strengthened by the necessary exclusion of 5 of the 6 cases in which the curves did not cross because of fever and forced fluids. It is well established that in febrile cases output of fluid through the urinary channels is markedly depressed. If in addition fluids are rapidly increased, the intake curve far outstrips the output curve. Yet in spite of such rapid increase in intake in febrile cases, the output curve appears to bear an abnormal relation to the intake curve in that it frequently approaches very near to crossing it in a relation which is not encountered in similar febrile conditions in the non pregnant. The relation of output to intake in these febrile cases was not studied beyond the 14 day period previously designated, there may have been a delayed readjustment.

In the chart of the remaining one normal individual whose output did not at any time exceed her intake, there is noted the same tendency for the output to approach abnormally near the intake on certain days.

It is evident that if among the many losses of fluid attendant upon delivery and the puerperium lactation alone was included in fluid loss in addition to urinary output the figures would appear abnormal to even a more astonishing degree.

Analysis of Table I and reference to Table II show that fluid excess is occasionally noted during the first 24 hour period after delivery is very commonly present on the second day

I shall not attempt to indicate the possible significance of fluid storage in pregnancy in relation to medical practices on pregnant women. Those who are better qualified in the various fields of medicine can best do that. That it has bearing on urinary infection in pregnancy, the treatment of cardiac cases in pregnancy, the management of eclamptics, and the demonstration of less need for attempting to maintain fluid reserves in postpartum conditions, is obvious.

I cannot refrain from observing that residual urines and retentions of large size may quickly occur wherever the response of the bladder to normal sensations is reduced as a result of bladder injuries caused by delivery or narcosis anesthetics. The relation of output to intake is no longer to be considered a safe guide as to the magnitude of the bladder content. Large bladder content if uninfected is of less significance than when infected. If infected, a postpartum febrile condition can be expected to occur with either retention or large residual urine formation. Theoretically, postpartum pyelitis can be considered entirely the result of faulty bladder management. It should be preventable. This increment of knowledge confirms me in my long established routine of placing on constant drainage those infected bladders and after 3 days of intermittent catheterization most uninfected bladders as soon as the fact of faulty emptying is established. I do not believe that the average nurse or obstetrician can palpate or percuss residual urine unless of large amount. Early catheterization of sleeping patients to prevent gross overdistention and subsequent atony is justified. Catheterization by the clock as is frequently practised is inconsistent with the demonstrated fluid excretion characteristics in the puerperium.

#### CONCLUSIONS

1 Pressure of the gravid uterus upon the ureters is not adequate to explain the changes

in the renal tree which commonly occur in pregnancy

2 A double etiology for these changes, if considered both as to nature and degree, should be accepted for humans. An endocrine factor should be given equal if not greater significance than the pressure factor.

3 There are several established lines of evidence which have in common certain characteristics in relation to the stage of pregnancy, which indicate that fluid storage in the course of pregnancy should occur regularly and in all cases.

4 In all except 1 of 54 cases studied over the average 14-day stay in the hospital after delivery, except in 5 febrile cases, there is an output of urine in excess of fluid intake too large and of too long duration to be considered accidental.

5 If fluid losses attendant upon delivery and the puerperium, purely obstetrical in nature, and lactation, be included, the above figures will be greatly exaggerated.

6 Medical and surgical and urological diseases, when they develop either in the course of pregnancy or the puerperium, should be considered in relation to a disturbed fluid balance and not by the yard stick of fluid balance in the non-pregnant.

#### REFERENCES

- 1 CRABTREE, E. GRANVILLE. Hydronephrosis in pregnancy. *J Urol*, 1937, 38 605. Read at the meeting of the American Urological Association, 1937.
- 2 CRABTREE, E. GRANVILLE, PRATHER, GEORGE C., and PRIEN, EDWIN L. *Am J Obst. & Gynec*, 1937, 34 405.
- 3 JANNLY, J. C., and WALKER, E. W. *J Am M Ass*, 1932, 99 2078-2083.
- 4 ROSSI, V. *Arch Ital di Urol*, 1936, 8 fasc 3.
- 5 ROWNTREE, LEONARD G. *Physiol. Rev*, 1922, 2 116-169.
- 6 SONDERN, FREDERICK, and HARVLY, THOMAS W. The phenolsulfonphthalein test for estimating renal function in pregnancy. *Bull Lying-In Hosp*, City of New York, 1911-1912, 8 172-175.
- 7 TRAUT, H. F., McLANE C. M., and KUDER, A. *Surg, Gynec & Obst*, 1937, 64 51.

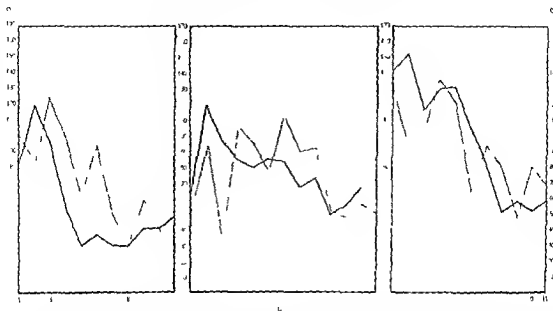


FIG. 8. Charts of 3 typical patients showing fluid balance when they emerge from delivery on forced fluid. O A quadripara retention of lochia low fever eleventh and twelfth days. C O B secundipara afebrile except for slight rise eleventh day normal thirteenth day. I W secundipara afebrile 36 week pregnant —intake —output

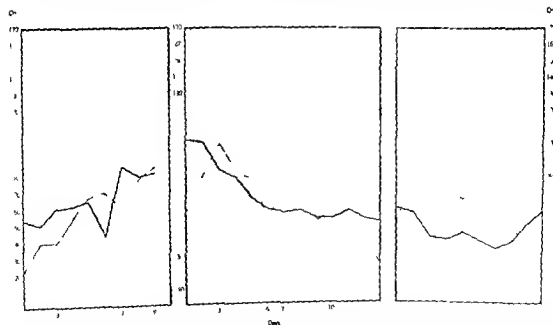


FIG. 9. Three charts showing fluid balance in cardiac disease. Two of the patients emerged from delivery on restricted fluids. A D tripura class III cardiac postpartum hemorrhage fever fifth and eleventh day. B C primipara class II cardiac dyspnea second day uterine inertia deformed pelvis afebrile. C C secundipara class I cardiac afebrile —intake —output

TABLE II — CLASSIFICATION AND TREATMENT OF ALL CASES

	Operable 65*	Inoperable 23†	Total 88
Number treated			
Histological grading			
Grade I	21	0	21
Grade II	24	5	29
Grade III	20	18	38
Type of treatment			
Abdominal hysterectomy	32	8	40
Vaginal hysterectomy	26	2	28
Hysterectomy plus radiation	19	10	29
Radiation only	7	13	20

\*73 86 per cent, †26 14 per cent

struates beyond the age of 48 years, should be closely followed and the possibility of endometrial malignancy kept in mind

*Associated hyperplasia* Hyperplasia of the endometrium is a frequent finding in women with a late menopause, and may be a predisposing factor in the development of malignant changes. In 17 of our cases the histological sections showed an associated hyperplasia. One of these had been diagnosed as a case of endometrial hyperplasia from a curettage performed 12 months previous to the finding of positive evidence of malignancy.

*Incidence of myomas* While 35 2 per cent of our fundus cancer cases had associated myomas, only 5 6 per cent of the total number of patients with fibromyoma treated within the same period had associated carcinoma. This still leaves unanswered the question of the etiological relationship between uterine fibromyomas and fundus cancer.

*Associated pathology—metastases* Howard Taylor finds that breast carcinoma is associated with fundus carcinoma in the proportion of 1 to every 130 cases of the latter. In this small series, the incidence was somewhat higher, since there were 5 patients who had been previously treated for adenocarcinoma of the breast. One of these died 3 months following treatment, and at autopsy, in addition to the uterine adenocarcinoma, fibrosarcoma of the uterus, lung, and liver was present. The ovary was found to be involved in 4 cases. One of these showed a fibrosarcoma, while in another a granulosa cell tumor was found. This latter case invites speculation upon the relationship between excess ovarian hormone and the pathological changes occurring in the endometrium.

TABLE III — CLASSIFICATION AND TREATMENT OF CARCINOMA OF THE BODY AND CERVIX OF THE UTERUS

	Operable	Inoperable	Total
Histological grading			
Grade I	2	0	2
Grade II	4	0	4
Grade III	4	1	5
Total	10	1	11*
Type of treatment			
Abdominal hysterectomy	8	0	8
Vaginal hysterectomy	2	0	2
Hysterectomy plus radiation	3	0	3
Radiation only	0	1	1

\*Incidence, 12 5 per cent

*Classification of cases* The comparison of results of different methods of treatment is of little value unless it deals with a uniform type of material. The rate of cure will necessarily vary with the care with which the primary material is selected and the principles which form the basis for selection. The importance of separating the operable cases when reporting results, has been stressed by Heyman (9) and Arneson, particularly when an attempt is being made to evaluate surgery and irradiation.

The clinical classification is further complicated by the fact that there exists a group of cases in which cancer can be demonstrated anatomically and histologically, in both corpus and endocervix. Heyman (10), who first drew attention to this, states that the possibility of comparing different statistics on corpus carcinoma will be entirely ruined if one clinic places these with the corpus cancers and another clinic groups them under the cervical cancers. He applies the term *carcinoma corporis et colli* to this type of lesion and classifies them separately under this heading. In the

TABLE IV — SURVIVAL RATE—TEN YEAR RESULTS

	Operable 12	Inoperable 4	Total 16
Total cases, 1919-1926			
Survival in years			
1	11	3	14
2	8	2	10
3	7*	1†	8
4	7	1	8
5	6‡	1	7
6	3	0	3
7	3	0	3
8	3	0	3
9	3	0	3
10	3§	0	3

\*58 33 per cent, †25 0 per cent, ‡50 per cent, §25 0 per cent



# CARCINOMA OF THE BODY OF THE UTERUS

## A Clinical and Pathological Review

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THIS study was undertaken with the object of reviewing and evaluating results in the treatment of carcinoma of the corpus uteri at The Barnard Free Skin and Cancer Hospital. It covers the years 1919 to 1936 within which period approximately 100 patients with corpus carcinoma presented themselves for treatment. The case records from the earlier years in which the histories or follow up were incomplete were discarded, leaving 88 cases which form the basis of this report. In this group, 98 per cent had a complete follow up and 80 per cent of the gross specimens were available for study.

**Race distribution.** It is generally assumed that carcinoma of the corpus uteri has a higher incidence in the colored race. Our figures, however, show that 73 per cent of the patients were white despite the fact that over one third of the total number of clinic patients are colored, and the figures show a high incidence of myomatous uteri in both races. It was noted that a high percentage of the patients with carcinoma of the uterus were obese and overweight.

TABLE I — AGE INCIDENCE

Age in years	No.	Percent
Under 30	1	2.15
30 to 40	4	4.54
40 to 50	27	30.54
50 to 60	24	27.27
60 to 70	25	28.40
70 to 80	7	9.09

**Age incidence.** Table I shows the age on admission of patients with carcinoma of the uterus. The youngest patient was 19, and the oldest was 77. The highest incidence occurred in the fourth and sixth decades, 22, or 25 per cent had not reached the age of 49. This corresponds with the recently published statistical study of Norris and Dunne, and illus-

trates the fact that corpus carcinoma occurs more frequently in the earlier decades than is generally assumed.

**Hereditary factors.** In such a small series, any factors dealing with heredity are necessarily inconclusive. A family history of cancer was obtained in 9 cases, or 12 per cent. It is of interest to note that in 5 of these cases there was a history of carcinoma on the maternal side.

**Effects of gestation.** The literature bears frequent reference to the influence of gestation on the incidence of carcinoma of the cervix (3, 13). The associated frequency of cervical irritation is considered a factor. In the case of corpus carcinoma, however, there is no evidence to show that gestation has any etiological significance. Our figures support this view as the cases were almost equally divided between nulligravidae and multigravidae.

**Symptoms and duration.** The predominant symptom was vaginal bleeding which did not correspond to any particular type. It averaged 9 months in duration prior to the beginning of treatment. Pain was a late manifestation of the disease.

**Relation to menopause.** Krieger in a study of 2,201 cases concluded that the average age of menopause is 47 years. Fifty-five patients in our series were past this age. Of these patients 85.5 per cent had not yet reached the menopause at 47 years and 54.5 per cent of them were still actively menstruating at the age of 50 while in 20 per cent this function persisted up to the age of 53 years. In one instance menopause was delayed until 60 years. This corresponds to the findings of Crossen and Hobbs in a similar series and illustrates the fact that late menopause is a common observation in women who develop adenocarcinoma of the corpus. These authors found that the incidence of late menopause in such cases was 4 times as high as it is in normal cases. This suggests that a woman who men-

From the Gynecological Clinic of The Barnard Free Skin and Cancer Hospital.

Read before the conjoint meeting of the St. Louis and Chicago Gynecological Societies, February 13, 1937.

26 per cent in the Radiumhemmet. It will be noted that all but one of these were operable cases and only one-half were immature lesions. Three of them displayed a separate small growth at the fundus, including one which had received radiation for adenocarcinoma of the cervix at another clinic 2 years previously. We believe that the possibility of involvement of the corpus in adenocarcinoma of the cervix is not sufficiently stressed and that the fundus should always be explored.

It is recognized that any woman manifesting abnormal uterine bleeding should have a diagnostic curettage. Immediate hospitalization was often impossible in our overcrowded institution, and in consequence of this, we have recently been using the Randall biopsy cannula. This has proved an efficient and convenient method for obtaining endometrial biopsies in the clinic at the first visit. Plentiful material can be thereby removed for examination, and the patient enters the hospital with the diagnosis confirmed, ready for treatment. The possibility of missing a small localized area of cancer should always be kept in mind and a thorough curettage is indicated in doubtful and suspicious cases.

**Results** Tables IV, V, and VI give the results of treatment over 10, 5, and 3 year periods, respectively. A considerable percentage of the patients came under treatment during the past 3 years and had to be eliminated from the calculations. In the operable group a 10 year survival rate of 67.7 per cent was achieved. In the inoperable group, no patients survived 10 years, and the 5 and 3 year cure rate was reduced to 20 per cent and 25 per cent, respectively. These results compare favorably with similar reported series (1) in which radiation was the only treatment used.

Table VII shows the survival rate of the body and cervix cases. All but 1 were in the operable group, yet only 1 lived 10 years, thus reducing the 5 years survival rate to 33.3 per cent.

#### SUMMARY AND CONCLUSIONS

1. An attempt is made to correlate the clinical and pathological findings in 88 cases of corpus carcinoma selected from the records

of the Barnard Free Skin and Cancer Hospital.

2. Seventy-three per cent occurred in the white race.

3. The highest incidence was equally divided between the fourth and fifth decades.

4. Gestation does not seem to be a factor in the predisposition to corpus carcinoma.

5. A family history of cancer was present in 12 per cent of the cases, of which more than half were directly attributed to the maternal side.

6. Late menopause is a common observation in women who develop fundal cancer.

7. There is reasonable evidence for the assumption that there is a relation between hyperplasia of the endometrium and fundus carcinoma.

8. The fundus should be explored in all cases of adenocarcinoma of the cervix.

9. Operation has been the treatment of choice. Recently use of radium before operation has been employed in the treatment of anaplastic lesions.

10. Results are calculated on the basis of 10, 5, and 3 year survivals. The poorest results were in the corpus and cervix cases, although a majority of the latter were not advanced cases.

#### REFERENCES

1. ARNESON, A. N. *Am J Roentgenol*, 1936, 36, 4.
2. BOWING, H. H., and FRICKE, R. E. *Am J Roentgenol*, 1931, 26, 738.
3. CROSSEN, H. S. *Am J Obst & Gynec*, 1933, 26, 686.
4. CROSSEN, R. J., and HOBBS, J. E. *J Missouri M Ass*, 1935, 32, 361.
5. HAAGENSEN. *Am J Cancer*, 1933, 19, 285.
6. HANSEMAN. Quoted by Haagensen.
7. HEALY, WILLIAM P. *Am J Obst & Gynec*, 1934, 1, 27.
8. HEALY, WILLIAM P., and CUTLER, MAX. *Am J Obst & Gynec*, 1930, 19, 457.
9. HEYMAN, JAMES. *Acta Radiologica*, 16, No. 90.
10. *Idem*. *Proc 4th Int Rad Congress, Zurich*, 1934.
11. KRIEGER. *Die Menstruation*. Quoted by Meissner and De Lee.
12. MAHLE, A. E. *Surg, Gynec & Obst*, 1923, 36, 385.
13. MCGINN, J. A. *Am J Obst & Gynec*, 1935, 29, 619.
14. NORRIS, C., and DUNNE, F. *Am J Obst & Gynec*, 1936, 6, 982.
15. TAYLOR, HOWARD. *Am J Cancer*, 1931, 1, 277, 3, 15.
16. ZWEIFEL, E. *Ztschr f Geburtsh u Gynaek*, 1933, 104, 498-515.
17. Report on Cases Treated at the Radiumhemmet 1921-1935, p. 51-104.

TABLE V.—SURVIVAL RATE—FIVE YEAR RESULTS

Total cases 1910-1931	Operable 20	Inoperable 12	Total 32
Survival in years			
1	27	6	33
2	14	4	18
3	12*	3†	15
4	11	3	14
5	10‡	3†	13

\*60.0 per cent. †25.0 per cent. ‡50.0 per cent. §15.0 per cent.

Stockholm Clinic 50 per cent of these cases are found to be advanced lesions involving the entire uterus, but about 25 per cent are early, without palpable changes. At the Radium hemmet, special attention is paid to the recognition of this group of cases. This is accomplished by the routine performance of a fractional curettage of the uterus. In this procedure the cervix is curetted before dilatation, then the fundus and then the lower segment, the curettings being collected in separate bottles. We have found it more practical to curette the lower segment of the uterus before exploring the fundus. This procedure also furnishes information on the site and extent of the lesion, which may be of practical value if the case is to be irradiated.

We have classified our cases into operable and inoperable groups, and have included the body and cervix cases in a separate group. The operability was predicated upon the extent of the disease, and in each case was verified by the chief of service.

**Histological grouping.** The histological classification comprises three groups. An analysis of the end results did not show sufficient divergence to warrant the separation of Group 1 cases into papillary adenoma malignum and adenoma malignum. It was therefore deemed more practical to adopt the criteria of Haagen sen (5) in preference to that of Mahle, Italy and Cutler (8) et al. Groups 1, 2 and 3 comprise the mature, intermediate and anaplastic types, respectively.

**Treatment.** Complete removal of uterus, adnexa, and a short vaginal cuff under spinal anesthesia has been considered the treatment of choice. Table II summarizes the classification and treatment of all cases. It shows that 73 per cent of the patients were considered operable at the onset of treatment.

TABLE VI.—SURVIVAL RATE—THREE YEAR RESULTS

Total cases 1910-1931	Operable 31	Inoperable 15	Total 46
Survival in years			
1	7	8	35
2	23	4	27
3	21*	3†	24

\*67.4 per cent. †13.3 per cent.

Vaginal hysterectomy, under local anesthesia, was employed in a large percentage of those cases termed technically operable which otherwise would be considered inoperable on account of some intercurrent disease or debility. In these, the Schuchardt incision was at times employed to facilitate exposure. The total operative mortality was 3.4 per cent. In accordance with the improved results reported in the literature (2, 7, 17) from the use of radium pre-operatively we have latterly adopted this method in the treatment of the anaplastic lesions. The maturity of the lesion was not an important factor in the operable group, as the three histological grades were approximately equally distributed. In the inoperable group however there was a predominance of the anaplastic type of growth. The patients in this group were treated with radium alone or radium in combination with surgery. In 10 of them an intra uterine application of radium produced sufficient clinical improvement to justify subsequent operation. It is of interest to note that our indications for operability have remained approximately the same for the past 17 years and parallel that of Heyman in a series of 156 cases in which patients were treated with radiation alone.

Table III summarizes the cases of cancer of the body and cervix of the uterus. The percentage incidence was only 12.5 per cent as compared with an average incidence of

TABLE VII.—SURVIVAL RATE IN CASES OF CARCINOMA OF BODY AND CERVIX OF UTERUS

Total cases 1910-1931	Number 6	Per cent
Survival in years		
1	4	66.66
2	1	50.00
3	2	33.33
4	2	33.33
5	2	33.33
10	1	16.66

26 per cent in the Radiumhemmet. It will be noted that all but one of these were operable cases and only one-half were immature lesions. Three of them displayed a separate small growth at the fundus, including one which had received radiation for adenocarcinoma of the cervix at another clinic 2 years previously. We believe that the possibility of involvement of the corpus in adenocarcinoma of the cervix is not sufficiently stressed and that the fundus should always be explored.

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#### REFERENCES

1. ARNISON, A. N. *Am J Roentgenol*, 1936, 36, 4.
2. BOWING, H. H., and FRICKE, R. E. *Am J Roentgenol*, 1931, 26, 738.
3. CROSSEN, H. S. *Am J Obst & Gynec*, 1933, 26, 686.
4. CROSSEN, R. J., and HOBBS, J. E. *J Missouri M Ass*, 1935, 32, 361.
5. HAAGENSEN, *Am J Cancer*, 1933, 19, 285.
6. HANSEMAN. Quoted by Haagensen.
7. HEALY, WILLIAM P. *Am J Obst & Gynec*, 1934, 1, 27.
8. HEALY, WILLIAM P., and CUTLER, MAX. *Am J Obst & Gynec*, 1930, 19, 457.
9. HEYMAN, JAMES. *Acta Radiologica*, 16, No. 90.
10. *Idem*. Proc 4th Int Rad Congress, Zurich, 1934.
11. KRIEGER. *Die Menstruation*. Quoted by Meissner and De Lee.
12. MAHLE, A. E. *Surg, Gynec & Obst*, 1923, 36, 385.
13. MCGILN, J. A. *Am J Obst & Gynec*, 1935, 29, 619.
14. NORRIS, C., and DUNNE, F. *Am J Obst & Gynec*, 1936, 6, 982.
15. TAYLOR, HOWARD. *Am J Cancer*, 1931, 1, 277, 3, 15.
16. ZWEIFEL, E. *Ztschr f Geburtsh u Gynaek*, 1933, 104, 498-515.
17. Report on Cases Treated at the Radiumhemmet 1921-1935, p. 51-104.

# THE TREATMENT OF COLON BACILLUS PERITONITIS IN RABBITS WITH ESCHERICHIA COLI ANTISERUM

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**I**N RECENT years considerable interest has been aroused in the use of serum in the treatment of peritonitis.

The preparations most commonly used have been polyvalent mixtures of various types of antisera. Weinberg (7) and Priestley (2, 3) have reported encouraging results in the treatment of diffuse peritonitis in human subjects using a polyvalent anaerobic serum, a colon bacillus serum, and a so called complementary serum against staphylococcus and streptococcus. Vincent, Weinberg and Prevot, and Perrando have also reported the use of combinations of anticolonic bacillary serum with other serums with good results both experimentally and in clinical practice.

Although these reports are favorable, there is as yet very little experimental evidence as to the value of any type of antiserum in the treatment of peritonitis. Furthermore, since peritonitis as encountered in clinical practice is usually a mixed infection it is difficult to say which type of serum should be the most effective.

In any peritonitis resulting from the perforation of the gastro intestinal tract the colon bacillus is practically always one of the invading organisms. In an attempt to investigate experimentally the possibility of bactericidal power in a colon bacillus serum we have conducted a series of experiments using a colon bacillus antiserum in the treatment of a pure colon bacillus peritonitis in rabbits.

**Experimental procedure.** Twenty three rabbits were actively immunized by repeated intravenous injections of a stock colon bacillus suspension as an antigen. Agglutination titres were checked and found to range between 1:1000 and 1:10,000 after the last injection.

The 23 immune animals together with 10 controls were given an intraperitoneal injection of colon bacillus gum tragacanth peri-

tonitis producing mixture. The mixture was prepared as described by Steinberg and Goldblatt. Eleven 6 inch agar slants incubated for 20 hours were harvested in 20 cubic centimeters of saline. An equal amount of 5 per cent gum tragacanth was added to the suspension and stirred until a homogeneous mixture was obtained. The lethal dose of this preparation was found to be 2 cubic centimeters per kilogram of rabbit weight. All inoculations of this material were given intraperitoneally.

The 10 controls receiving the peritonitis producing mixture died within 14 hours. Two of the 23 immune animals died within 20 hours. The 21 other rabbits survived with no ill effects. This observation would seem to be strong evidence that the antigen injected animals had developed an active immunity against the colon bacillus.

These surviving rabbits were sacrificed for serum. Sufficient 1:20 merthiolate solution was added as a preservative to give the serum a terminal dilution of 1:100,000 merthiolite. The combined serum of the 21 rabbits was found to give an agglutination titre of approximately 1:2000.

**Treatment of rabbits with colon bacillus antiserum.** Ten groups of rabbits were given a lethal injection of colon bacillus gum tragacanth peritonitis producing mixture and treated with the anticolonic bacillary serum. The number of animals in each group, including 2 or more controls, varied from 3 to 6. In order to simplify the data the 10 groups of animals are combined in the following table.

A total of 24 rabbits received *intravenous* injections of serum. Twelve animals were given 1 injection of 5 cubic centimeters per kilogram of anticolonic bacillary serum 5 minutes after intraperitoneal injection of peritonitis producing mixture. Of these 12 animals, 5 died and 7 survived. The 12 other animals treated intravenously received 2 injections of

5 cubic centimeters per kilogram of anticoli-bacillary serum at 5 minutes and 6 hours after intraperitoneal injection of peritonitis producing mixture. Of these 12 animals, 9 survived, and 3 died.

Ten rabbits were treated *intraperitoneally* with anticolibacillary serum. Three of these received one injection of 5 cubic centimeters per kilogram of antiserum 5 minutes after peritonitis producing mixture was injected. All 3 animals died. The 7 other animals received 2 injections of 5 cubic centimeters per kilogram of antiserum 5 minutes and 6 hours after injection of peritonitis producing mixture. Only 1 of the 7 animals survived.

Thirty-one controls were used in these experiments. Eight of the controls received normal rabbit serum intravenously in similar doses to the animals treated with anticolibacillary serum intravenously, and 8 others received physiological salt solution by the same route and dosage. Fifteen others were untreated. All controls died within a period of 18 hours. Necropsy revealed a serosanguineous peritonitis in all animals that died. Rabbits weighing approximately 2 kilograms were used throughout.

*Results of blood cultures.* Blood cultures were taken on 15 of the rabbits which were treated intravenously with anticoli serum. All of the cultures were taken at 6 hours and previous to a second injection of serum. Five of these treated animals died and all had positive blood cultures. Of the cultures examined from the 10 surviving rabbits, 4 were positive at 6 hours, and 6 were negative. Cultures were again taken at 24 hours on the surviving animals and all were negative. All cultures were checked routinely up to 72 hours.

Blood cultures taken 6 hours after injection from 5 of the animals treated intraperitoneally were all positive for colon bacillus. All these animals died.

Blood cultures were taken on 15 of the controls. All cultures were taken at 6 hours, and all were positive. All died with a terminal septicemia.

The possibility of saving rabbits by waiting over 5 minutes before beginning specific intravenous therapy was considered. Two animals were treated at 1 hour, and 2 at 2 hours,

and 2 animals at 3 hours after intraperitoneal injection of peritonitis producing mixture. All animals received 2 injections of 5 cubic centimeters anticolibacillary serum per kilogram. The first injection was given at 1 hour, 2 hours, or 3 hours as previously designated. The second injection was given 2 hours later. All animals succumbed along with the controls.

In the preceding experiments the peritonitis producing mixture was prepared from the same strain of colon bacillus as was used to prepare the serum. We have recently treated a few animals with a concentrated anticolibacillary serum prepared as recommended by Schwartzman<sup>1</sup>. The strain of colon bacillus used to produce peritonitis in this group of animals was isolated from the peritoneal cavity of a dog with peritonitis. The Schwartzman anticoli serum agglutinated this organism in a dilution of 1 to 200. Three series of animals were treated. Twelve animals each received two intravenous injections of 2 cubic centimeters of Schwartzman anticoli serum 5 minutes and 6 hours after injection. Six controls received the same amount of normal horse serum. Seven of the group of the 12 treated animals survived. All controls died within 16 hours as shown in Table II.

#### RESULTS OF STUDY

The type of peritonitis we have produced by this experimental procedure is not com-

TABLE I—RABBITS INJECTED WITH COLON BACILLUS GUM TRAGACANTH PERITONITIS PRODUCING MIXTURE, SHOWING THE EFFECT OF TREATMENT WITH COLON BACILLUS ANTISERUM

Treatment	Number rabbits	Survivals	Deaths	Mortality per cent
Bacillus coli antiserum intravenously	24	16	8	33.3
Bacillus coli antiserum intraperitoneally	10	1	9	90.0
Normal rabbit serum intravenously	8	0	8	100.0
Normal salt solution intravenously	8	0	8	100.0
Untreated	15	0	15	100.0

<sup>1</sup>We express our appreciation to the Research Laboratories of Eli Lilly Company for supplying this serum.

TABLE II — RABBITS TREATED WITH SHWARTZMAN ANTICOLIBACILLARY SERUM AFTER INJECTION OF BACILLUS COLI GUM TRAGACANTH PERITONITIS PRODUCING MIXTURE

	Anti colibacillary serum injected daily	Controls
Number of rabbits	1	6
Survivals	7	0
Deaths	5	6
Mortality (per cent)	43	100

parable to that encountered in human subjects, and we are making no effort to discuss clinical application at this time. The results we have reported would seem to indicate strongly that the serums used have a definite antibacterial action against the colon bacillus. However we are not in a position to discuss the mechanism of therapeutic action. Information gained from blood culture studies would seem to indicate that the serum acts in some manner to prevent an overwhelming terminal septicemia.

CONCLUSIONS

1 Rabbits actively immunized against the colon bacillus were able to survive in high percentage a colon bacillus peritonitis produced by intraperitoneal injection of a mixture which was fatal to controls

2 A majority of animals may be saved from diffuse bacillus coli peritonitis if treated immediately with anticolibacillary serum intravenously. The mechanism of therapeutic action apparently depends upon the fact that the serum in some way prevents an overwhelming invasion of the blood stream

BIBLIOGRAPHY

1 PERRAUD C. Die Serumtherapie der akuten peritonitis. *Vlinisch experimentelles Beitrag. Zentralbl f Chir* 1935 62 83-88

2 IRELAND J. Serum therapy as adjunct to surgical treatment of appendicitis with rupture and peritonitis. Preliminary report. *Proc Staff Meet Mayo Clinic* 1933 8 753-755

3 Idem. Further observations on serum therapy in treatment of peritonitis secondary to appendicitis. *Proc Staff Meet Mayo Clinic* 1936 11 213-214

4 SHWARTZMAN GREGORY and WINKLEMAN ASHER. A new type of serum therapy for the treatment of non specific ulcerative colitis. *Am J Digest Dis* 1934 1 582

5 STEINBERG B. and GOLDBLATT H. Studies on peritonitis: production of experimental peritonitis and survival following intraperitoneal injection of *Bacillus coli*. *Arch Int Med* 1927 39 446-449

6 VINCENT H. Medical applications of anti-colibacillary serum. *Am J M Sc* 1932 193 301-309

7 WEINBERG M. Serothérapie de l'appendicite gangreneuse et de la peritonite. *Compt rend Acad dsc* 1911 11 497-499

8 WINKELMAN M. and IRELAND J. R. Du serum anticolibacillaire. *Compt rend Soc de biol* 1934 116 1 69-120

# THE ANATOMICAL AND SURGICAL FEATURES OF ECTOPIC KIDNEY

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**A**NOMALOUS human organs are frequently of more than anatomical importance, since their occurrence may produce a disturbed physiology, and so ultimately require surgical removal

Among the most striking of congenital anomalies is the ectopic kidney. A kidney may be classified as ectopic by virtue of its aberrant location, its odd shape, short low pedicle, anterior pelvis or short ureter. The location has been described by Braasch as pelvic, iliac, or abdominal. The short ureter and the bizarre pelvis and calyces and in distinguishing between an ectopic and a ptotic kidney

On account of their varieties ectopic kidneys have received clinical consideration by many writers, excellent studies have been published by Thomas and Barton, Thompson and Pace, MacKenzie and Hawthorne, Judd and Harrington, Campbell, and many others. Ectopic kidney is not uncommon, the occurrence of 154 has been recorded in a total of 128,322 autopsies, an incidence of 1 in 833<sup>1</sup>, but, since published accounts of excised surgical specimens are not numerous, it was considered advisable to place on record the current case of renal ectopia. The presence in the dissection laboratory of an excellent example of ectopia furnished an opportunity to follow in detail the anatomical relations of abnormal,

and associated normal, kidney—particularly those important relations having to do with the arterial supply and venous drainage.

Both the anatomical and the surgical specimens were characterized by the possession of an anterior pelvis, each was low in position with short ureter, each had a complex arrangement of renal vessels. In the anatomical specimen no hydronephrosis was evident, in the surgical specimen a marked intrarenal hydronephrosis occurred, the result of infundibular constriction produced by anomalous renal vessels.

## ANATOMICAL SPECIMEN

The cadaver in which the anatomical specimen was studied was a muscular, male negro, 5 feet 11 inches in height, weighing 121 pounds (embalmed), and aged 70 years. Figures 1 through 7 show successive stages in the dissection of this specimen.

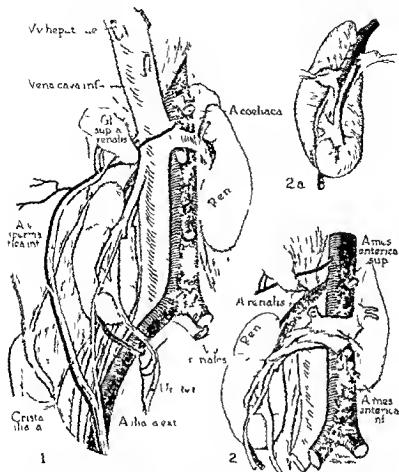
*Right side* The right kidney was moderately lobulated, the hilus widely open and directed anteriorly (Fig 1). The organ rested chiefly upon the psoas major muscle, extending from the level of the lower third of the second, to that of the middle of the fifth, lumbar vertebra, its upper two-thirds was therefore abdominal in position, its lower one-third pelvic. The inferior extremity covered the lumbo-inguinal nerve; the lateral femoral cutaneous nerve emerged from the lateral margin of the psoas major muscle at the point to which the muscle was covered by the kidney, skirting the lateral margin, at the superior pole, was the combined trunk of the iliohypogastric and ilio-inguinal. The ureter entered the broad hilus in two portions, the lower was exposed as it divided into major calyces, while the upper was concealed by the renal veins.

The upper portion of the kidney was supplied by a renal branch of the aorta which arose at the level of the lower third of the first lumbar vertebra (Figs 1 and 2). Follow-

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<sup>1</sup>However, the recorded incidence of ectopic kidneys noted in clinical examinations is considerably lower. Thomas and Barton 6 in 3,285 urological examinations, Thompson and Pace 1 in 10,000 admissions at the Mayo Clinic, MacKenzie and Hawthorne 13 in 15,000 examinations. Thompson and Pace suggest the discrepancy between necropsy and clinical examination was due to the fact that many ectopic kidneys were asymptomatic, special examination not indicated, and they were not diagnosed. They point out that in 52 of 88 clinical cases the diagnosis was established during the course of the urological examinations, including pyelographic studies, in the other 36, the diagnosis was made at the time of surgical exploration. An uninfected ectopic kidney with adequate urinary drainage frequently remains asymptomatic and may be discovered only during the course of an operation or at necropsy.





Figs. 1, 2 and 2a. Anterior abdominal and pelvic structures, especially of the right half of the body. Anterior and slightly lateral views. Three-eighths natural size.

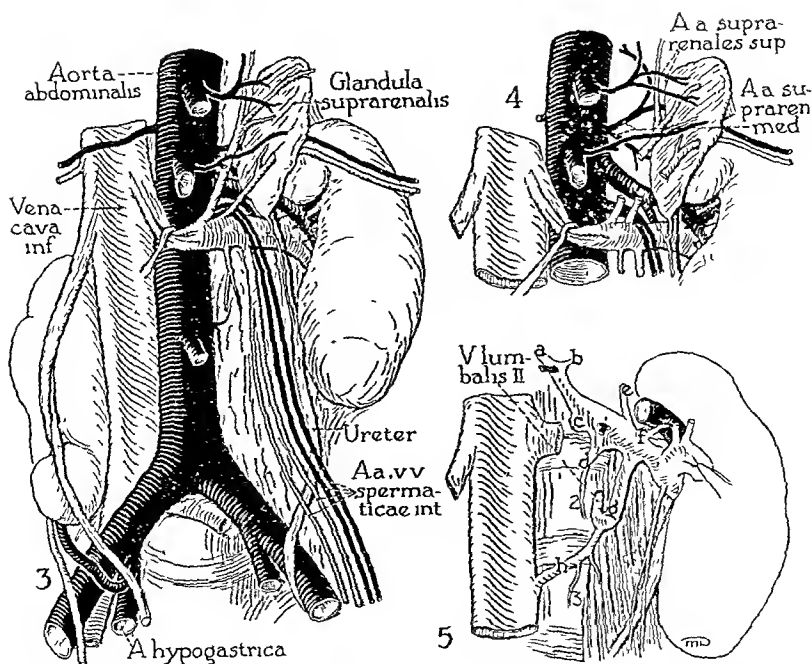
Fig. 1. The arteries and veins of the anomalous kidney of the suprarenal gland and testes with the principal structures related to the two organs. The kidney is 1 upon the quadratus lumborum, psoas major and diaphragm muscles. Left crus of diaphragm cut, liver totally removed, the hepatic tributaries of the vena cava transected. The hypogastric origin of the anomalous renal artery is not in view.

Fig. 2. The structures in the immediate area of the right kidney. The inferior vena cava has been cut and turned forward to show the two renal and a parietal vein and the two sets of suprarenal arteries.

Fig. 2a. The anomalous kidney excised, the veins retracted to reveal the arrangement of vessels and of ureter within the anteriorly placed hilum. The internal spermatic vein removed to show its ulcer.

ing an oblique course downward and lateral ward, it appeared from beneath the inferior vena cava where the latter received the right renal vein. The artery divided into three branches: two of these pierced the renal substance on the floor of a sulcus which was continuous with the widened hilum (Figs. 2 and 2a); the backward directed stem entered the

parenchyma behind the superior extension of the hilum (Fig. 2a). The anterior one of the hilar branches gave off several twigs to the upper extremity (shown by retracting the vessel in Fig. 2a) then disappeared by passing between the tributaries of the adjacent vein; the posterior hilar branch passing behind the superior vein, coursed downward along the



Figs 3 to 5 Posterior abdominal and pelvic structures, especially of the left half of the body. Three-eighths natural size

Fig 3 The arteries and veins of the kidney, suprarenal gland and testes, the left renal vein has been drawn inferiorly to show more clearly the constituents of the renal pedicle

Fig 4 The suprarenal veins have been transected, the gland lifted superiorly, in order to show the origin and course of the renal, suprarenal, and spermatic arteries

Fig 5 The aorta has been excised, the renal vein transected and turned aside to show the prevertebral venous plexus and its relation to the second lumbar vein

medial margin of the hilus. The lower portion of the kidney was supplied by an arterial branch derived from the hypogastric close to its origin (Figs 1 and 3), turning upward, and crossing the external iliac artery and the psoas major muscle, it pierced the lowermost portion of the inferior extremity, within a sulcus (1 centimeter in depth), continued downward from the hilus.

From the upper portion of the hilus a renal vein left the kidney (Fig 1), it was formed by the junction of two vessels which emerged from the parenchyma (Figs 2 and 2a). Into the inferior one of the two tributaries the right internal spermatic vein passed. The renal venous tributaries, in the hilus, passed to either side of the more anteriorly placed branch of the renal artery (drawn apart in Fig 2a). The anterior one of the two vessels drained chiefly the lower part of the kidney, while the posterior one carried blood mainly

from the upper portion. Veins were situated in front of, between, and behind the subdivisions of the ureter.

The right renal veins did not communicate with the ascending lumbar vein of the corresponding side, however, the lumbar system did form an anastomosis with the peri-aortic ring contributed by the renal veins of the left side.

The right ascending lumbar vein began as a tributary to the common iliac vein (Fig. 7). As it passed the fifth lumbar vertebra no lumbar vein was sent medialward to the inferior vena cava, but tributaries were received at this point from the vertebral canal. A small fourth lumbar vein was present. At the third segment a lumbar vein of fair size connected the ascending lumbar system with the inferior vena cava. Between the third and second segments the ascending lumbar vein was small, but opposite the second vertebra,

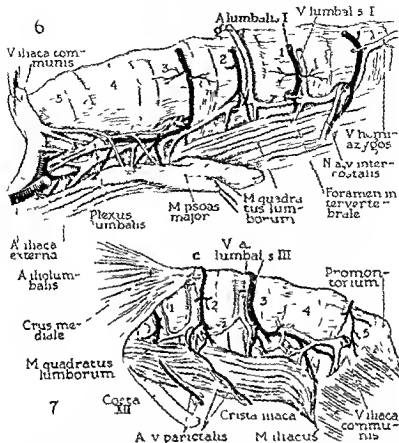


Fig 6 The ascending lumbar vein and related structure of the left side the psoas major muscle has been freed and turned aside the quadratus lumborum muscle is intact the left crus of the diaphragm has been removed to display the communication of the lumbar with the azygos system of veins The second lumbar vein here indicated by arrow is the vessel shown in Fig 5 which communicated with the circum aortic ring

Fig 7 The ascending lumbar vein and the lumbar arteries of the right side with related structures the crus of the diaphragm partially covers the first lumbar vertebra the quadratus lumborum muscle (the psoas major removed) the iliac muscle below the brim of the greater pelvis The lumbar plexus of nerve has been removed

the lumbar vein again enlarged, in addition to tributaries from the psoas major muscle and the vertebral plexus two tributaries were received from the posterior abdominal wall. It was with the second lumbar vein that one of the tributaries of the retro aortic venous plexus communicated. Continuing cranial ward, the ascending lumbar vein passed beneath the crus and became continuous with the azygos vein in the thorax (Fig 5).

The arrangement of the lumbar arteries was somewhat irregular. The fifth lumbar artery

terminated in the fine twigs on the vertebra, the fourth was wanting, the third the largest of the group sent branches into the inferior three intervertebral foramina the second and first supplied unusually prominent branches to the musculature of the back. No segmentally arranged branches of the aorta were sent to the kidney (Anson, Richardson and Vaneer 1936 Figs 8 to 11).

**Left side.** The left kidney was normal in form and in position (Fig. 3) its inferior extremity did not quite reach the level of the

crest of the ilium, extending from the middle of the twelfth thoracic to the lower third of the third lumbar vertebra.

The exposed course of the single renal artery was very short. It arose from the aorta opposite the upper third of the first lumbar vertebra, appearing from beneath the inferior extremity of the suprarenal gland, the artery quickly divided into two branches which entered the hilus of the kidney (Figs 3 and 4). The single renal vein was a vessel of large size and transverse course, it crossed the aorta just beneath the origin of the superior mesenteric artery, at the level of the intervertebral fibrocartilage between the first and second lumbar vertebrae. It received on its cranial margin an inferior phrenic vein (which had suprarenal tributaries) and a suprarenal vein, just lateral to the suprarenal vein a pair of internal spermatic arteries arched over the renal vein. On its caudal margin the renal vein received an internal spermatic, formed by the junction of two tributaries, lastly, a small vein from preperitoneal tissue surrounding the aorta.

A prevertebral venous plexus occurred in association with the left renal vein (Fig 5). The plexus, imbedded in the thin stratum of connective tissue which intervenes between the great vessels and the vertebral column, was so placed that its existence would not be suspected by the surgeon, yet, in a current study of the renal and suprarenal territory, it was found that a comparable set of intercommunications is of frequent occurrence.<sup>1</sup>

The plexus began superiorly in two small veins, one from each crus of the diaphragm (Fig 5 *a* and *b*), at their junction they formed a hiatus for the passage of a branch of the first lumbar artery. Widening somewhat, this channel received on its inferior aspect a communicating vein from the ascending lumbar system of the opposite side. This communicating vein (second lumbar of the right side), and the anastomotic vessel from the plexus (Fig 5 at *c*) together joined the inferior vena cava

(Fig 2, at *c*). Next, the retro-aortic plexus received a small parietal vein, of medial course, from the surrounding connective tissue (Fig 5, *d*), then, superiorly, a vein from the left crus of the diaphragm (Fig 5, *e*). Adjacent to this diaphragmatic vein were two small renal tributaries (Fig 5, *f*), which, en route to the common venous channel from the superior part of the hilus, surrounded the renal artery. On the inferior aspect of the channel a large vein, the second lumbar, entered from the psoas major muscle (Fig 5, *g*). The lumbar vein emerged from the vertebral margin of the left psoas major muscle opposite the middle of the second lumbar vertebra, its drainage was not only muscular, but meningeal and osseous as well (Fig 6 *g*). In prevertebral position its shape was that of a letter J, from the lowermost part of its curve a communicating branch was sent obliquely downward and to the right to bring this post-aortic group of veins once more into connection with the inferior vena cava (Fig 5, *h*), the latter anastomosis established at the level of the middle of the third lumbar vertebra. The venous vessels just described passed behind the aorta, the renal vein proper passed in front (Figs. 3 and 4), together they surrounded the aorta to form a circum-aortic venous ring<sup>1</sup>. They communicated at a point 1 centimeter medial to the hilus of the left kidney.

The renal drainage on the left side was brought into communication with the ascending lumbar system by means of this lumbar vein (Fig 6, at *g*). The ascending lumbar vein itself was divided into two portions one inferior, one superior to, the third lumbar vertebra (Fig. 6), the drainage passing inferiorly and superiorly from this line of division. The superior portion was, as already mentioned, related to the renal vein. The second lumbar vein passed deeply into the psoas major muscle, attaining the level of the roots of the transverse processes. At the foramen between the second and third lumbar vertebrae it received a meningeal tributary, and in that locality several muscular tributaries from the psoas major; from above, one lumbar vein entered the ascending lumbar, passing superiorly, it became the hemi-azygos

<sup>1</sup>In a comprehensive study of the renal and suprarenal vessels by Anson, Pick, and Beaton, 128 cadavers have been examined to date, in 15 of these (11.7 per cent), the circum-aortic ring occurs, not infrequently, and in a manner to be described in a subsequent publication, the deeper one of the transverse veins communicates with a prevertebral venous plexus, and with lumbar veins (Fig 5). These features have been described and figured by Lejars (1888), recently by Odgers (1931), Fagrasanu (1938), and others.



Fig 3 Right retrograde pyelogram showing the renal pelvis of bizarre form the dilated minor calyces and the short ureter

The veins inferior to the level of the third lumbar segment drained caudalward and were not segmentally arranged, interrupted between the levels of the second and third lumbar vertebrae, the meningeal veins emerging from the lower lumbar vertebrae (third, fourth, fifth), formed a venous trunk into which passed also muscular tributaries from the psoas major muscle the trunk emptied into the common iliac vein into which latter also drained a second vein from the fifth lumbar level. The corresponding arteries were derived from two sources the ilio-lumbar branch of the hypogastric (inferiorly), the third lumbar artery (superiorly) no segmental arteries occurred at the fourth and fifth.

From this description it should be clearly evident that the parietal and visceral venous channels are intimately related. Thus, beginning with the pelvic level in the specimen described, the iliac veins received vessels from the pelvic organs, muscles, and skeleton by means of the lumbar veins (Figs 6 and 7)

blood was brought to the inferior vena cava, not only from the lumbar skeleton and musculature but from the spinal cord and its meningeal investments, additionally these veins received parietal rami (Fig 7) from the retroperitoneal connective tissue, and their major trunk the ascending lumbar vein, communicated with the common iliac vein (Fig 6). In the subphrenic region, the chief caval tributaries were, of course, received from the kidney, one of these passed anterior to the aorta (Fig 4) the other posterior to that axial vessel (Fig 5). The pre-aortic vessel drained not only the kidney, but also the testis, suprarenal gland, retroperitoneal tissue, and diaphragmatic musculature. The retro-aortic vein, through its plexiform arrangement of tributaries, drained the muscle constituting the crura of the diaphragm, the areolar tissue housing the great vessels, and the upper extremity of the kidney (by means of minute veins), it communicated directly with the ascending lumbar system by means of the second lumbar vein. Through the continuity of the lumbar with the azygos system (Fig 6), communication was established between the pelvic abdominal parietes and contents and the thoracic wall and serous membranes.

The importance of this anastomosis in the spread of infection through the entire renal and deep lumbar areas is obvious. The rich set of anastomoses may account for the spread in cases reported by other investigators. Thus Israel (1911) and Bavard (1921) noted that fatal tuberculous meningitis may follow nephrectomy for tuberculosis. Another fatal case was recently reported by Turner, death occurring 36 days postoperatively. Autopsy revealed no tubercular foci in the nephrectomy area. In the presence of rich venous anastomoses direct intrameningeal contamination could easily occur as the result of renal manipulation incidental to nephrectomy.

#### SURGICAL SPECIMEN

An ectopic kidney is subject to all the diseases which may assail a normal kidney in addition as a result of its anomalous development aberrant vessels, constrictions, and adhesions may predispose to malfunction and pathological changes. When urinary drainage

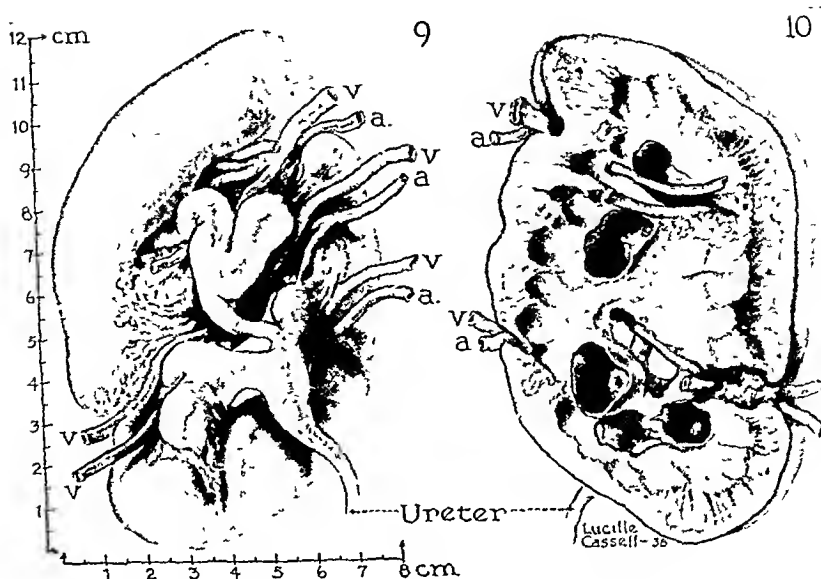


Fig 9 Excised right kidney (same as Fig 8) with anterior pelvis (injected with wax) Showing the bifid pelvis, the numerous hilar arteries and veins which course along each side of the infundibula (see arrangement of the vessels in Fig 1). Abbreviations a, artery, v, vein

Fig 10 The dorsal half of the same kidney, showing on the cut surface, the cavitation at the minor calyces

is incomplete, symptoms of indefinite low abdominal pain and backache occur, frequently accompanied by hydronephrosis, infection, or calculus

When indicated, ectopic kidneys causing symptoms are preferably treated by nephrectomy. In 21 cases with ectopic kidney treated surgically, reported by Thompson and Pace, the kidney was removed in 17. MacKenzie and Hawthorne performed 7 nephrectomies and 1 exploratory operation for neoplasm in 13 cases. In Judd's series of 19 pelvic kidneys only 10 required surgery. Thomas treated his 6 ectopic kidneys surgically, presumably by nephrectomy.

In the present case, renal ectopia caused distressing vague abdominal pain and backache. Nephrectomy was necessary owing to the unusual relationship of the renal vessels to the infundibula.

C J, female, aged 27 years, entered the Passavant Memorial Hospital January 31, 1936, complaining of vague right abdominal pain and backache associated with frequency, urgency, dysuria, and nocturia for 8 years. The appendix had been removed for the above complaint 2 years before. There was a

history of measles, mumps, whooping cough, chicken pox, malaria, and scarletina during childhood. The general physical examination was essentially negative except for an asymptomatic scoliosis. Complete urological investigation revealed a low lying, fixed, uninfected right kidney with good function. Right retrograde pyelogram (Fig 8) revealed a bifid pelvis, dilated minor calyces and a short ureter. The left kidney was thought to be normal. The bladder and urethra revealed a low-grade chronic infection. The bladder urine contained pus cells (grade II), motile bacilli and motile trichomonas. The culture revealed bacillus coli. Under gas anesthesia on June 9, 1936, an extraperitoneal right nephrectomy was performed. The postoperative convalescence was uneventful and the patient experienced complete relief of pain in the right abdomen and back.

The surgical specimen (Figs 9 and 10) measured 7 by 12 centimeters. The kidney was unusually flat and oval in shape, the renal pelvis was bifid and anteriorly placed, the hilus open and unobstructed. There were 4 separate arteries and veins. Surfaces made by cutting exposed the dilated minor calyces, appearing as cavities measuring 1 to 2 centimeters in diameter. In the anomalous pedicle, due to early division of the arteries and veins, the vessels surrounded and passed close to the infundibula as they emerged from the renal parenchyma. This vascular arrangement produced a "vise-like" constriction sufficient to produce the intrarenal hydronephrosis. Two veins entered the lateral margins of the kidney,

although their origin was not identified at the time of operation it is reasonable to suppose that they were related to either iliac or hypogastric veins (see arteries Figs. 2 and 3).

The authors are indebted to Earl W. Cauldwell and Hugh Wilson for the careful preparation of the anatomical dissections.

#### REFERENCES

1. ANDERSON B. J., RICHARDSON G. A. and MINER W. L. Variation in the number and arrangement of the renal vessels. *J Urol* 1936 36 211-219.
2. BAYARD ANDRÉ. Theses medicales Lyon 1920 and 1921, 53 201-210.
3. BOUTETON C. A. and ANDERSON B. J. Pelvic kidney and renal vessels in a newborn child. *J Urol* in press.
4. BRAASCH W. F. The clinical diagnoses of congenital anomaly in the kidney and ureter. *Tr Am Ass Genito Urol Surg* 1931 8 381-397.
5. CAMPBELL M. I. Penial ectopy. *J Urol* 1930 24 18-193.
6. FAGARASA U. I. Recherches anatomiques sur la veine rénale gauche et ses collatérales. *Ann d anat path et norm méd-chir* 1938 15 9-52.
7. ISRAEL J. Die Endre ultare der Nephrektomie bei Nieren tuberkulose. *Folia urolog* 1911 6 257-266.
8. JUDG F. S. and HARRINGTON S. W. Ectopic or pelvic kidney. *Surg Gynec & Obst* 1913 28 446-451.
9. LEJARR. Les voies de sûreté de la veine rénale. *Bull Soc anat de Par* 1889 2 (ser) 504-511.
10. MACKENZIE D. W. and HAWTHORNE A. B. The ectopic kidney. *Tr West Branch Am Urol Ass* 1937 6 13-20.
11. ODGERS F. N. B. Circum aortic venous ring. *J Anat* 1931 66 (pt 1) 98-99.
12. THOMAS G. J. and BARTON J. C. Ectopic pelvic kidney. *J Am M Ass* 1936 106 191-199.
13. THORNTON C. J. and JACK J. M. Ectopic kidney. *Surg Gynec & Obst* 1937 64 935-943.
14. TURNER J. H. Meningitis following nephrectomy for tuberculosis: case report and review of the literature. *J Urol* 1935 34 216-221.

# PRIMARY RETICULUM CELL SARCOMA OF BONE

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THE type of primary bone tumor to be described in this paper apparently constitutes a definite group which has not been recognized in the past. No provision for this group has been made in the classification of the Registry of Bone Sarcoma of the American College of Surgeons. In the Registry cases included in this present study the diagnosis of primary reticulum cell sarcoma was first suggested in 1931 (Registry No 1059). It was not until 1936 that an initial diagnosis of primary reticulum cell sarcoma was made (Registry No 1992). Prior to this date these cases had been variously classified as Ewing's sarcoma, Hodgkin's disease, lymphosarcoma, osteogenic sarcoma, leucosarcoma, or as inflammation. In view of these facts it seems worth while to emphasize the characteristics of this type of bone tumor and describe its clinical course, especially as this neoplasm seems to have a more favorable course than its appearance would indicate.

From our own material and from the Registry of Bone Sarcoma, we have collected 17 cases of primary reticulum cell sarcoma of bone. Of these, 10 were male, 7 female. The age distribution differs materially from that of the generalized form of reticulum cell sarcoma, which is primarily a disease of middle and old age—84.5 per cent of all cases occurring after the age of 40 and less than 1 per cent being found under 20 years of age. As will be seen from Table I, 77 per cent of the primary reticulum cell sarcomas of bone occurred under the age of 40 and 35 per cent under the age of 20.

In the generalized form of the disease, metastatic bone lesions occur most commonly in the vertebræ and skull. In sharp contrast, primary reticulum cell sarcoma of bone is found to be present most frequently in the long or flat bones (Table II).

From the Thorndike Memorial Laboratory, the Second and Fourth Medical Services (Harvard), the Mallory Institute of Pathology, Boston City Hospital, the Department of Medicine, Harvard Medical School, Boston, the Collis P. Huntington Memorial Hospital, Harvard, and the Pondville Hospital, Wrentham.

Clinically, the onset is similar to that of other primary bone sarcomas, namely, with pain not relieved by rest. Pain localized at the site of disease or referred to the joint nearest the tumor was the first symptom in 13 cases, in 3, a pathological fracture brought the patient to the physician, in 1, a painless swelling of the bone and surrounding soft parts was the chief initial complaint. An obvious and tender swelling of the affected part was noted in 8 instances. The general health of the patient was good in all but 2 cases, in these there had been considerable loss of weight and strength. In none was fever noted, in no instance were abnormalities found in the peripheral blood picture. The few blood calcium and phosphatase determinations which were done were within normal limits, but the number of determinations were too few to be significant. A history of injury preceded the initial symptoms in 5 cases, but we have no good evidence that trauma is actually of etiological importance. It is more probable that a minor injury brought on symptoms in an already diseased bone or that a previous injury was recollected by the patient when symptoms of importance supervened. Perhaps the most important clinical feature is that an extensive, painful, destructive process in a long bone is found in a patient whose general condition is good. In no other bone sarcoma is the contrast between the comparative well-being of the patient and the size of the lesion so marked.

TABLE I — AGE DISTRIBUTION OF PRIMARY RETICULUM CELL SARCOMA OF BONE

Age	No cases	Age	No cases
0-9	0	30-39	4
10-19	6	40-49	2
20-29	3	50-59	2

TABLE II — BONE INVOLVED IN PRIMARY RETICULUM CELL SARCOMA OF BONE

Location	No cases	Location	No cases
Femur	5	Humerus	3
Clavicle	4	Scapula	1
Tibia	3	Mandible	1



although their origin was not identified at the time of operation it is reasonable to suppose that they were related to either iliac or hypogastric veins (see arteries Figs 1 and 3)

The authors are indebted to Earl W. Cauldwell and Hugh Wil on for the careful preparation of the anatomical dissections

#### REFERENCES

1. ANSON B J, RICHARDSON G A and MINEAR W L. Variations in the number and arrangement of the renal vessels. *J Urol* 1936 36 217-219
2. BAYARD ANDRE. *Theses médicales*. Lyon 1900 and 1921 53 201-10
3. BOYLSTON C A and ANSON B J. Pelvic kidney and renal vessels in a newborn child. *J Urol* in press.
4. BRAASCH W F. The clinical diagnosis of congenital anomaly in the kidney and ureter. *Tr Am Ass Genito-Urin Surg* 1931 8 381-392
5. CAMPBELL M F. Renal ectopy. *J Urol* 1930 24 187-198
6. FAGARASANU I. Recherches anatomiques sur la veine rénale gauche et ses collatérales. *Ann d anat path et norm méd-chir* 1938 15 9-52
7. ISRAEL J. Die Endresultate der Nephrektomie bei Nieren tuberkulose. *Folia urolog* 1911 6 257-286
8. JORD F S and HARRINGTON S W. Ectopic or pelvic kidney. *Surg Gynec & Obst* 1919 28 446-451
9. LEJARS. Les voies de sûreté de la veine rénale. *Bull Soc anat de Par* 1888 2 (5 ser) 504-511
10. MACKENZIE D W and HAWTHORNE A B. The ectopic kidney. *Tr West Branch Am Urol Ass* 1937 6 13-20
11. ODGERS P A B. Circum aortic venous rings. *J Anat* 1951 66 (pt 1) 98-99
12. THOMAS C J and BARTON J C. Ectopic pelvic kidney. *J Am Med Ass* 1936 106 197-199
13. THOMPSON G J and PACE J M. Ectopic kidney. *Surg Gynec & Obst* 1937 64 935-943
14. TLERNER J H. Meningitis following nephrectomy for tuberculous case report and review of the literature. *J Urol* 1935 34 216-221

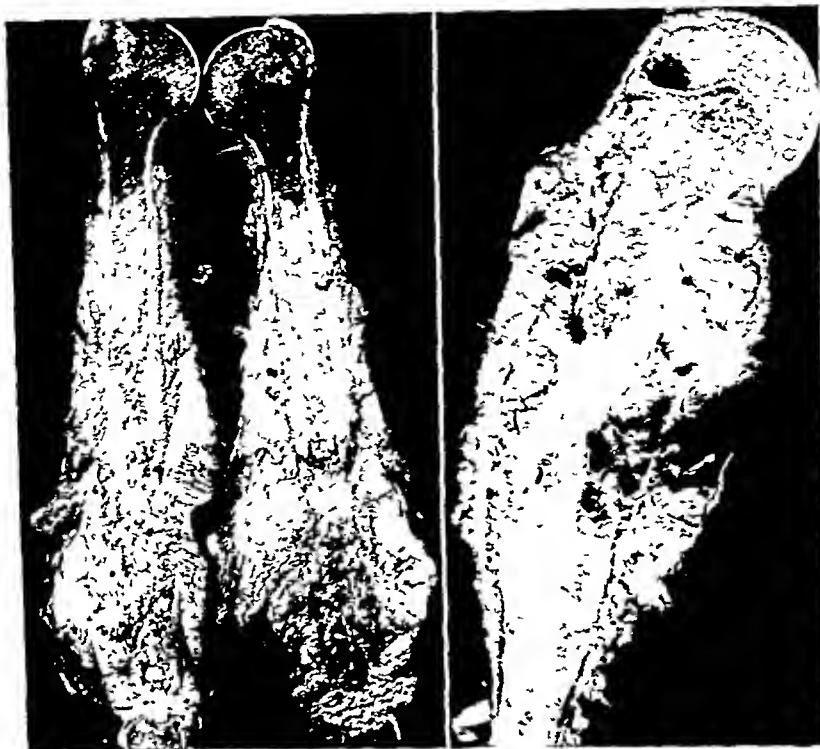


Fig 6, left Registry Case No 564 Gross specimen, humerus  
 Fig 7 Registry Case No 83 Gross specimen, humerus

We wish, however, to emphasize the importance of early diagnosis and treatment, for by these means only can one expect to obtain the best results. In 1 instance, signs and symptoms definitely pointing to a tumor of the femur had been present for a year and 4 months before amputation, and the condition had been variously diagnosed as tuberculosis and as arthritis. At the time of operation, the tumor had reached massive size and inguinal lymph nodes had appeared. The patient was dead 3 months later. It is not improbable that, had an accurate diagnosis been made by biopsy at an earlier date, the results would have been better.

The x-ray appearance is by no means pathognomonic. The disease is most frequently seen in the ends of the long bones and extends from the metaphysis into the diaphysis (Figs 1 to 4). In 3 cases the middle of the clavicle was the site of the tumor, in 1 the middle of the mandible was the point of origin

In general, x-ray examination shows chiefly bone destruction, and to a much less degree new bone formation, sometimes incident to a pathological fracture. In early cases there may be only mottled bone destruction in the medulla (Figs 1 and 2). In 1 early case, very fine striations extended from the irregularly thickened cortex and periosteum into the adjacent soft tissue. In the more advanced cases, there is extensive involvement of bone with marked osteolysis and only moderate or no osteogenesis (Fig 3). Pathological fracture (Fig 4) occurs occasionally and in those cases callus formation may complicate the picture. There is often fragmentation of the cortex and a widening of the shaft as if from an expansive tumor pressing from within outward. Periosteal thickening may be seen both early and late. Invasion of surrounding muscle is common. The disease has been mistaken by radiologists for osteomyelitis, osteogenic sarcoma, Ewing's tumor, and Hodgkin's disease.



Fig 1 Registry Case No 1992 Roentgenogram of femur  
Fig 2 Registry Case No 1900 Roentgenogram of tibia  
Fig 3 Registry Case No 83 Roentgenogram of humerus



Fig 4 Registry Case No 564 Roentgenogram of humerus

In no other bone tumor may the lesion be so extensive and at the same time be so amenable to appropriate treatment

The disease had existed, as suggested by the symptoms for many months in several cases before the services of a physician were sought. In 7 cases, symptoms had been present for a year or more before treatment, and yet 5 of these patients are alive and apparently well from 3 to 14 years later. This very fact attests the comparatively benign nature of what appears roentgenographically, clinically, and histologically to be a highly malignant tumor.

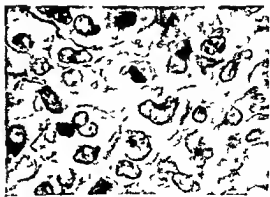


Fig 5 Registry Case No 564 Photomicrograph Hematoxylin-eosin stain X 927

*Lymphosarcoma* The type cell with its round nucleus, scanty cytoplasm, and spherical shape should offer no difficulty. In our experience, true lymphosarcoma of bone is extremely uncommon.

*Ewing's sarcoma* Reticulum cell sarcomas have been most frequently erroneously diagnosed as Ewing's sarcoma. In the latter, the uniform character of the cells and of their nuclei, the arrangement in strands and cords, and the distribution of the reticulum are diagnostic features. In Ewing's sarcoma, the reticulum surrounds groups of cells, while in reticulum cell sarcoma not only does the reticulum surround groups, but it also runs between the individual cells.

*Osteogenic sarcoma* Some of the reticulum cell sarcomas have been diagnosed as atypical osteogenic sarcomas. The lack of any tumor, bone, or cartilage formation, the absence of osteoid tissue, and the morphology of the tumor cells should serve to exclude this diagnosis.

*Inflammation* The diagnosis of inflammation was made in 2 cases in the Registry. The presence of the large mononuclear cells and lymphocytes with, in addition, necrosis, have proved misleading. In one of our own cases, the infarct type of necrosis and marked cellular infiltration of the vessel walls led to the incorrect diagnosis of syphilis.

Since there have been no autopsies on the cases of reticulum cell sarcoma described, it might be argued that we are not justified in terming this group primary reticulum cell sarcoma of bone. However, the complete lack of evidence of a primary tumor elsewhere and the favorable course following amputation argues for the primary nature of this tumor. It is common knowledge that a small and, indeed, unrecognizable primary tumor, as in carcinoma of the breast or bronchus, may give rise to large metastatic lesions, but it would be most unusual to have a secondary lesion of massive size arise and still have the primary tumor remain silent 14 years after the amputation of the metastatic lesion, as in Registry Case No. 564. Furthermore, those patients who had inadequate treatment have shown evidence, before death, of metastases rather than the appearance of a primary tumor concealed, for a time, in an internal organ. Generalized lymph node

and pulmonary metastases were found in one case. In another, a second tumor appeared in another long bone. In a third case, not included in the present series because we have only a lymph node biopsy (there had been a destructive lesion of the femur for 2 years prior to this biopsy), there appeared, before death, generalized lymphadenopathy, splenomegaly, hepatomegaly, and destructive lesions in the radius, humerus, and pubis.

The following cases illustrate the course of the disease.

W B, a single man, aged 44 years (Bone Sarcoma Registry No. 564), was admitted to the Massachusetts General Hospital October 1, 1924. His past history was uneventful.

Since January, 1924, he had experienced moderate pain in the right upper arm. In May, 1924, while playing baseball, he fractured his right humerus. An x-ray film taken at this time showed no evidence of tumor. The bone, however, did not unite well and in August, 1924, the patient noticed a swelling of the middle of the right upper arm. Although the pain decreased, the tumor increased in size. An x-ray examination on October 2, 1924, showed destruction of the humerus throughout nearly its entire extent (Fig. 4). There was little if any new bone formation although there had been 6 months before a fracture in the midportion. The new-growth extended nearly to the head of the humerus. The proximal portion of the ulna appeared to be involved by a similar process.

On October 9, 1924, a shoulder joint amputation was performed. In 1924, this tumor was diagnosed as medullary sarcoma and as osteolytic sarcoma. In 1925, a diagnosis of osteogenic sarcoma was made, and in 1930 the condition was believed by one reviewer to be a benign giant cell tumor. In 1934, it was first suggested that the tumor was a reticulum cell sarcoma, the diagnosis being based on the criteria set forth in this paper.

Convalescence was uneventful and the patient remained entirely well until October, 1931, when a tumor developed in the amputation scar. This mass was excised and showed the same histological picture as did the original bone tumor. The patient has remained well and active to date, January, 1938, 14 years from the onset of symptoms.

That the disease was most extensive at the time of operation is attested by Figure 6, a photograph of the gross specimen removed in 1924.

W S, a boy, aged 15 years (Registry No. 1663), aside from the usual childhood diseases, had been quite healthy. In the spring of 1927, he noticed a tender swelling in the region of the left knee. Radium was applied (in unknown doses) and the pain



Fig 8 Registry Case No 1762 Tumor stained by Foot-Hortega silver method  $\times 283$



Fig 9 Registry Case No 1762 Tumor growing in vein Wright elastic tissue stain  $\times 57$

In gross appearance, the tumor varies considerably. In early cases the medullary cavity is found to be invaded by pinkish gray granular tissue. In more advanced cases, the bone destruction and soft tissue involvement referred to elsewhere is obvious. The tumor in these instances is usually firm, smooth, and glistening; more rarely it is soft and friable. The color is variously described as pale, white, pinkish gray and gray white. Areas of necrosis are frequent and may merge into cavities resembling osteomyelitis.

The type cell (Fig 5) is identical with that of reticulum cell sarcoma of lymph nodes and other tissues. The nature of this cell and the histogenesis of reticulum cell sarcoma in general will be taken up in a subsequent paper. The cell is larger than a lymphocyte. The nucleus, which is from  $1\frac{1}{2}$  to 2 times larger than that of a lymphocyte, varies in shape from round to oval; frequently it may be indented or lobulated. In the cells of well differentiated tumors, the chromatin is finely divided and scattered. In the more anaplastic it tends to be coarser and nucleoli may be prominent. The cytoplasm varies in its staining reaction from acidophilic to basophilic and may be considerable in amount in relation to the nucleus. The cell varies from round to oval to elongated. Evidence of ameboid activity as indicated by shape of cell and its nucleus, is frequently present and is indeed a characteristic feature. Binucleate forms occur but true tumor giant cells do not. Mitotic figures are often present in large number.

The stroma varies in amount from delicate strands of collagen to dense bundles. When stained in order to bring out the reticulum, this is found to occur running in delicate threads and strands around groups of tumor cells and also between individual cells (Fig 8).

A fairly common feature of these tumors is the growth of the cells in the walls of small veins (Fig 9). In such veins the endothelium is lifted and the lumen is encroached upon and distorted by the tumor cells in the intima. A similar involvement of arteries or arterioles has not been seen. Necrosis of the infarct type is often a prominent feature. Scattered foci of lymphocytes are frequently found to be present.

Complete destruction and obliteration of the normal constituents of the marrow is constantly found. Osteolysis is often a prominent feature. The tumor cells do not form bone, but new bone formation by the stroma does occur. Invasion of the surrounding soft parts is common.

Reticulum cell sarcoma must be differentiated from the following conditions:

**Hodgkin's disease.** The granulomatous form with sclerosis, necrosis, eosinophils and Reed-Sternberg cells should present no difficulty. The sarcomatous form in which the majority of the cells are of the mononuclear type may simulate closely anaplastic reticulum cell sarcoma but the presence of even an occasional typical Reed-Sternberg cell should serve as a differential point. Primary Hodgkin's disease of bone we believe to be very rare indeed.

Histologically, the tumor cells have round, oval, indented, or lobulated nuclei which are nearly twice the size of that of a lymphocyte. The chromatin is scattered and the cytoplasm is considerable in amount.

In spite of its apparently malignant nature, the tumor is amenable to appropriate treatment, 13 of the 17 cases being alive from 6 months to 14 years from the initial symptom. Seven of these patients have been apparently free from disease 10 or more years.

Five patients were treated by amputation alone. Of these, 2 are dead, 3 are alive from 3 to 11 years from onset. We have already referred to a possible explanation for the deaths in this group.

Three patients were treated by radiation alone. Of these 1 is dead, 2 are alive from 1 to 3 years later, but in each there is still neoplastic disease.

Of the 9 patients treated by amputation and radiation, 8 are alive from 6 months to 14 years from onset.

From a consideration of the cases presented, the best procedure would appear to be early diagnosis by biopsy followed by immediate amputation and radiation.

#### ABSTRACT OF CASE HISTORIES

Be, male, aged 31 years. In June, 1926, the patient sustained a minor injury to the knee. During the following summer there was gradually increasing pain and swelling of the knee. In October, 1926, an x-ray film showed a destructive lesion of the lower end of the femur with some periosteal thickening. In November, 1926, a biopsy was done and the following diagnoses were made: sarcoma, myeloma, syphilis, chronic inflammation. On December 17, 1926, a mid thigh amputation was performed. The patient died September 10, 1927, with generalized lymph node metastases and metastases in the spinal canal and lung.

Sr, male, aged 35 years. In February, 1924, the patient felt something snap in his shoulder and he was incapacitated for a few days. In January, 1925, he felt another sharp pain in his left shoulder. Gradually swelling appeared over the left upper scapula. On April 1, 1925, an x-ray examination showed a destructive process in the scapula involving the spine and the acromial process. A diagnosis of osteomyelitis or sarcoma was made. Radium needles were inserted, the mass, however, continued to grow and the patient died October 24, 1925, following a massive hemorrhage from the original tumor.

Registry No 1951, female, aged 48 years. In the spring of 1934, the patient noticed some stiffness in

her left knee. In August of the same year, there developed considerable pain and swelling of the knee. In October, 1934, an aspiration biopsy was done and a tentative diagnosis of tuberculosis was made. By July, 1936, the pain had become much worse and the patient was put in a Thomas splint with traction. In January, 1936, there had developed an enormous swelling of the lower half of the thigh and enlarged inguinal lymph nodes. A hip joint amputation was done and a diagnosis of Ewing's tumor was made. X-ray therapy was instituted. The patient died April 26, 1936, with pulmonary and lymph node metastases.

Registry No 83, female, aged 12 years. In February, 1920, the patient sustained a pathological fracture of the left humerus. Examination shortly thereafter showed a lobulated tumor of the upper half of the humerus. The mass was red, tender, and fluctuant. An x-ray examination showed a destructive process of the upper half of the left humerus and a pathological fracture. A shoulder joint amputation was done and a diagnosis of osteogenic sarcoma was made. The patient was lost sight of and died April 24, 1932, from a presumed "tumor of the right knee."

Bu, male, aged 14 years. H.H. No 37-1599. In July, 1937, the patient sustained a mild injury to the right lower jaw. In September of the same year he noticed a painless lump in the middle of the right mandible. An x-ray examination showed an irregular increase of density of the right mandible and fine striations radiating into the surrounding soft tissues. On December 31, 1937, the right half of the mandible was resected and the patient given 1500 r units high voltage x-ray. The tumor was diagnosed as a reticulum cell sarcoma. The patient was alive and well March 7, 1938.

Registry No 1992, female, aged 15 years. In the winter of 1935-1936, the patient noticed an intermittent pain in her right knee with some limitation of motion of the knee. On August 4, 1936, the general physical examination was normal. There was some thickening over the lower end of the right femur with slight limitation of motion of the knee. An x-ray picture showed a mottled destruction in the lower 2 inches of the femur without expansion and with little if any periosteal reaction. From a biopsy specimen on July 31, 1936, a diagnosis of reticulum cell sarcoma was made. The patient was given high voltage x-ray with symptomatic relief. The x-ray picture, however, remained essentially the same. The patient's condition was essentially unchanged August 5, 1937.

Registry No 1867, female, aged 58 years. In June, 1934, the patient noticed a pain in the left chest which finally localized in the left sternoclavicular joint. In February, 1935, a tumor appeared at the inner end of the left clavicle. On June 5, 1935, the general physical examination was normal. There was an egg-sized tumor of the inner end of the left clavicle. A biopsy was performed and the lesion was variously diagnosed as mixed cell osteogenic sarcoma

and swelling completely receded for a period of 6 months. All symptoms then returned and the patient lost 30 pounds in weight. An x ray examination on March 25, 1929 showed an irregular lesion involving the cortex and medulla of the proximal third of the shaft of the tibia. The lesion was mottled in appearance due to irregular zones of bone destruction intermingled with dense zones of new bone formation. The cortex was roughened and the periosteum lost in a large soft tissue swelling enveloping the knee. A diagnosis of Ewing's tumor was made and amputation was done March 26, 1929. This specimen was diagnosed in 1934 as Ewing's sarcoma. In 1936 as questionable reticulum cell sarcoma and as Ewing's tumor. In 1936 a definite diagnosis of reticulum cell sarcoma was made. Recovery was uneventful, and the patient is well and free from symptoms or signs of disease at present 10 years after the onset of the tumor.

It is impossible at present to conclude what the best form of treatment is. Amputation followed by radiation to the adjacent lymph nodes, however, would appear to give the best results. In one instance (Registry Case No 1523) excision appeared to be adequate, but we believe that amputation should be done when ever possible. In addition, radiation would seem advisable. A biopsy of the lesion may safely be done prior to amputation, but it should be emphasized that only by careful microscopic examination of a properly fixed and stained section can the correct diagnosis be made.

Three cases (Registry Nos Sr, 1992, 1867) received radiation only. One of these died in less than 2 years with a massive hemorrhage from the original tumor. Two cases are still alive, in one (Registry No 1992), the original tumor by x ray examination seems to be essentially unaltered a year later, in the second (Registry No 1867), a pathological fracture had just appeared in another long bone after 3 years.

Two cases (Registry Nos 1663, 1723), had initial radiation with complete disappearance of both signs and symptoms, but, in each instance, the tumor recurred locally within 6 months. Amputation was then done and the patients are both alive and apparently free from disease 10 and 12 years from onset.

One case (Registry No 1909) was given x ray therapy for 5 years, but the symptoms steadily increased and lymph node metastases appeared. Amputation was then performed,

and the patient is living and apparently well 14 years from onset.

In 6 cases, amputation was followed by x ray therapy. In 4, radiation was given immediately after amputation. Three of these are alive and well respectively 8 months (Bu), 8 years (Registry No 1932), and 10 years (Registry No 1039) from onset. The fourth patient (Registry No 1951) died in 2 years of pulmonary and lymph node metastases after the amputation of a massive tumor of the femur which had been present for over a year and from which the inguinal lymph nodes had already become involved before operation. In another instance (Registry No 547), excision of the tumor was followed 8 months later by a questionable metastasis in another long bone which was subjected to radiation therapy. The patient is alive and well 14 years later. In the sixth patient (Registry No 564), a new neoplastic lesion appeared in the amputation scar after 7 years. This mass was excised and given radiation treatment as well. The patient is alive and well 14 years from the first symptom.

In 5 cases amputation only was done. Of these, 1 (Be) died somewhat over a year later following a mid thigh amputation for a lesion of the femur. A hip joint amputation would probably have been preferable. One patient (Registry No 83) died 12 years from onset with a questionable metastasis in another long bone, no further follow up having been made.

The 3 other cases (Registry Nos 1762, 1523, M C) are alive from 3 to 12 years from onset. From a consideration of these data it would appear that amputation plus radiation offers the best chance of cure.

#### SUMMARY

Seventeen cases of primary reticulum cell sarcoma of bone are presented.

The disease may be seen at any age, usually occurs in the long or flat bones and in spite of involving a given bone very extensively usually leaves the patient in good general condition.

Röntgenographically the lesion is primarily destructive, often massive. In the early stages diffuse medullary mottling may be the only sign. Later the expansive tumor may give rise to fragmentation of the cortex and pathological fracture.

February, 1923, there appeared a swelling of the middle of the right clavicle. The patient lost 30 pounds in weight. On June 20, 1923, the clavicle was excised and x-ray therapy was given to that region. This tumor was diagnosed as Ewing's tumor (1925), endothelioma (1930), and reticulum cell sarcoma (1934). In February, 1924, he experienced some pain in the shaft of the ulna. An x-ray film showed a questionable lesion in the ulna. X-ray therapy was given. On April 28, 1936, the patient was found to be alive and well, having completely regained his weight.

Registry No 1932, male, aged 36 years. In late January, 1930, the patient experienced considerable pain in the right hip with resulting limitation of motion on that side. April 3, 1930, the patient fell and fractured the neck of his right femur. The resulting pain and disability were sufficient to warrant a resection of the end of the femur. The specimen removed, B C H S-30-1139, showed reticulum cell sarcoma. Following operation, the patient was given high voltage x-ray therapy for a period of 4 months. The patient was alive and well with no signs of recurrence in April, 1938.



and reticulum cell sarcoma. An x ray examination showed a pathological fracture of the clavicle, bone destruction and expansive tumor. High voltage x ray therapy was given with symptomatic relief. On August 4, 1937 there appeared a pathological fracture of the humerus apparently due to a metastatic tumor.

Registry No 1762 male, aged 29 years. In the summer of 1933 the patient noticed transient pain in the left knee. In the winter of 1933-1934 the pain became worse. In April 1934 the tibia was incised and a diagnosis of osteomyelitis was made. A discharging sinus resulted and in May 1934 some gelatinous material was obtained from which a diagnosis of osteomyelitis was made. In September 1934 a large fungating tumor at the upper end of the tibia appeared and a diagnosis of Ewing's sarcoma was made. Amputation was done on September 19, 1934 at junction of middle and lower thirds of femur. Patient alive and well in February, 1937.

M C female aged 24 years. M G H 33 2637. In December 1932 the patient noticed slowly increasing pain in the right knee. In October, 1933 there was diffuse swelling in the lower third of the right femur. An x ray picture showed thickening in the lower part of the femur with diffuse mottling of the medullary cavity and periosteal thickening. A mid thigh amputation was done October 16, 1933. The patient was reported alive in March, 1938.

Registry No 1059 female aged 18 years. In June 1927 the patient felt listless and had been losing some weight. There was a painful swelling of the left clavicle near the sternum. A physical examination showed a tumor of the inner end of the clavicle and a diagnosis of cyst was made. The clavicle was incised and the necrotic material removed. A diagnosis of osteomyelitis was made. On October 4, 1927 the microscopic sections of material removed were reviewed and a diagnosis of Ewing's sarcoma made. The clavicle then was completely excised. In 1930 this tumor was variously diagnosed as Ewing's sarcoma atypical sarcoma osteogenic sarcoma and giant cell tumor. In 1931 a diagnosis of reticulum cell sarcoma and lymphoblastoma was made. In November, 1927 the patient was given x ray therapy over the region of the clavicle and was reported alive and well August 28, 1937.

Registry No 1663 male aged 13 years. In March 1927 the patient fell and humped his knee. Following this there was pain, tenderness and slight swelling in the left knee. During the summer of 1928 radium was applied with the improvement of symptoms and the disappearance of the swelling. The tumor however recurred and the patient lost 30 pounds in weight. On March 25, 1929 an x ray film showed in the proximal two thirds of the tibia an irregular lesion involving both the cortex and medulla. The periosteum was lost in a huge soft tissue mass. A diagnosis of Ewing's tumor was made. An amputation was done March 26, 1929 with an uneventful recovery and a return to normal weight. The patient was alive and well March 10, 1937.

Registry No 1523 female aged 58 years. On December 15, 1925 the patient fell and struck her right shoulder with resulting severe pain and swelling. An x ray examination on January 17, 1926 showed a pathological fracture of the surgical neck of the right humerus with a destructive process of the upper third of the right humerus, an elevation of the periosteum, and some thickening of the surrounding soft tissues. On January 25, 1926 the upper third of the humerus was excised. This tumor has been variously diagnosed as undifferentiated sarcoma (1933), leucosarcoma (1933), reticulum cell sarcoma (1934), lymphoblastoma (1934), reticuloendothelioma (1934). The patient was alive and well September 21, 1937.

Registry No 1723 male aged 34 years. On August 8, 1925 the patient sustained a pathological fracture of the right clavicle. An x ray picture showed a pathological fracture and a destructive lesion of the outer and middle thirds of the clavicle and a large soft tissue mass. X ray therapy was given with the disappearance of the tumor and a union of the fracture. The tumor however, recurred and on March 26, 1926 the clavicle was excised. This tumor was diagnosed as Ewing's sarcoma (1934), reticulum cell sarcoma (1935) and lymphoblastoma (1935). The patient was alive and well August 14, 1937.

Registry No 1909 male aged 26 years. In August 1923, the patient noticed tenderness, edema and heat over the upper tibia. A diagnosis of osteomyelitis was made. On June 28, 1930 a biopsy was done and a diagnosis of sarcoma made. High voltage x ray was given but a lymph node appeared in the groin in November 1931. This was excised December 4, 1931 and a diagnosis of lymphoblastoma made. X ray therapy was continued but the pain and tenderness increased and on August 16, 1935 a mid thigh amputation was done. The patient was alive and well May 22, 1937.

Registry No 564 male aged 44 years. In January 1924 the patient noticed pain in the right humerus. He was treated with ultraviolet light. In May 1924 he fractured his right humerus while throwing a baseball. In August 1924 the patient noticed a tumor of the lower end of the humerus but no pain. On October 2, 1924 an x ray examination showed a destructive tumor of the lower third of the humerus with a small amount of new bone formation and a pathological fracture. The growth extended nearly to the head of the bone and what appeared to be a similar process was seen in the head of the ulna. On October 9, 1924 a shoulder girdle amputation was done. This tumor has been variously diagnosed as medullary sarcoma and osteolytic osteogenic sarcoma (1924), benign giant cell tumor and osteogenic sarcoma (1930) and reticulum cell sarcoma (1934). In October 1931 a tumor appeared in the amputation scar. This was excised and given x ray therapy. The patient was alive and well January 1, 1938.

Registry No 547 male aged 14 years. In May 1922 he had some pain in the lower right arm. In

ment produces waves of this length. The sensitivity of the negative emulsion therefore limits the possibilities of infra-red photography to some extent. According to the same authors 21 per cent of the total incident energy is reflected by the skin surface, 66 per cent penetrates the stratum corneum and 50 per cent penetrates to the subcutaneous tissue. Waves of 1200 micromicrons undergo complete extinction in 3 millimeters of dead tissue and in the opinion of these authors would undergo more rapid extinction in living tissue due to the effect of the blood. The indistinct or hazy appearance of the veins is due to the scattering of the waves in the tissues. This is similar to the scattering of visible light, especially in the violet and blue region, caused by atmospheric haze. For this reason fine detail cannot be expected of structures as deep as  $\frac{1}{2}$  millimeter. It is unlikely, according to Hardy and Muschenheim, that photography of structures deeper than 2 millimeters is possible by infra-red waves, even if the sensitivity of the plates is increased to include waves of 1200 micromicrons, due to the complete extinction of these waves at a depth of little more than 2 millimeters of tissue.

The veins appear in the pictures because there is less reflection of infra-red waves from the areas traversed by the veins than there is from the tissue between the veins. In other words, the veins absorb more of the waves than does the tissue lying between them.

#### METHOD

The subjects for this study included pregnant women from the prenatal clinic of the Boston Lying-in Hospital, normal non-pregnant women, women from the sterility clinic of the Free Hospital for Women in Brookline, Massachusetts, and 1 patient from the Free Hospital for Women with a large fibroid uterus. The pregnant subjects were photographed at intervals of 2 to 8 weeks throughout pregnancy, the last antepartum pictures being taken as near term as possible. Postpartum pictures were taken when the patients were allowed up, usually from the tenth to the fourteenth day, but in some cases at the eighteenth to the twenty-fourth day. Patients were also photographed at the post-

partum clinic visit at about 6 weeks, and again several months later after the cessation of lactation. The normal non-pregnant women were photographed both during and between menstrual periods. The patients from the sterility clinic were photographed several times, in order to have control observations should any of them become pregnant. One of these patients did conceive as did 1 of the other group of non-pregnant women. The patient with the large abdominal tumor was photographed both before and after operation.

There were 35 pregnant women in the series, of whom 20 were primigravidae and 15 multigravidae. There was a total of 14 non-pregnant women. Six of the primigravidae and 4 of the multigravidae had organic heart disease. Of the patients with heart disease, 1 had a patent ductus arteriosus and 1 had coarctation of the aorta. The others all had rheumatic heart disease with mitral stenosis and insufficiency. Three of the primigravidae and 1 of the multigravidae developed toxemia. One woman was followed throughout her first and second pregnancies, 2 pictures being obtained between the 2 pregnancies. There were 2 cases of twins, both of these mothers developed toxemia. Three of the women were photographed before as well as during and after pregnancy. There were an albino and two negroes in the series. Several of the subjects were also being used for other studies of the circulation in pregnancy (8). These studies included serial determinations of blood volume, venous pressure, circulation time, red blood cell count, hemoglobin, hematocrit, and vital capacity. Several of the non-pregnant subjects were photographed at various phases of the menstrual cycle. In the case of the patient with the large fibroid the abdomen was enlarged to the size of a 6 months' pregnancy.

The regions photographed were the trunk anteriorly and posteriorly and, in a few cases, laterally, and the lower extremities anteriorly and posteriorly. An occasional ordinary panchromatic picture was taken for comparison. A few pictures were taken with the subject lying in bed immediately after delivery, but as it was impossible to obtain the same perspective it is difficult, if not impossible, to

# A STUDY OF THE SUPERFICIAL VENOUS PATTERN IN PREGNANT AND NON-PREGNANT WOMEN BY INFRA-RED PHOTOGRAPHY

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**T**HIS is one of a group of studies of various aspects of the circulation in pregnancy carried out at the Boston Lying in Hospital under the Department of Obstetrics of Harvard Medical School. Our aim was to demonstrate visually, if possible, any changes occurring in the superficial venous pattern before, during, and following pregnancy, and to attempt to correlate these changes with other facts pertaining to the circulation in pregnancy. For comparison some observations were made on non pregnant women.

Infra red photography of the veins has been done for several years. Masopust (6, 7) has published some observations on the superficial venous pattern in pregnancy with photographs comparing the veins of a primipara and a multipara. He suggests that there are differences peculiar to primiparity or multiparity. He also states that 'the gradual changes in the breasts indicate that a gradual preparation for lactation is taking place which reaches its maximum directly after delivery when the mammary glands are actively functioning. Our conclusion on the first point is directly opposed to his. In addition, we do not feel that such an explanation of the breast venous changes is complete.

Infra red photography is fundamentally the same as ordinary photography but a different region of the spectrum is used. This has been made possible by the development of negative material sensitive to wave lengths in the near infra red, or from about 700 micromicrons to 1100 micromicrons, with maximum sensitivity at about 800 micromicrons. Plates or films which are sensitive to infra red waves

are also sensitive to visible light and ultra violet waves and it is necessary to exclude these waves so that exposure may be made only to infra red rays. Since the type of plate used for most of this study was insensitive to visible red this was most conveniently done by placing over the lens of the camera a filter which allowed only red and infra red rays to pass. Any sort of camera may be used for infra red photography for which infra red sensitive films or plates are obtainable. A camera which is equipped with a ground glass focusing screen is the most convenient type.

The camera used for this study was a Graflex, series D with a Zeiss tessar f 4.5 lens, using either plates or cut film, size  $3\frac{1}{4}$  by  $4\frac{1}{4}$  inches. The lights were two 500 watt tungsten projection bulbs in reflectors. First man infra red sensitive plates type 1R were used for most of the work, but for the latter part a new type of plate called simply Eastman infra red sensitive plate was used. A Wratten filter No. 25 was used with the type 1R plate. The new type of plate, however, is also sensitive to visible red rays and since the No. 25 filter transmits these a Wratten No. 87 filter, which is opaque to all wave lengths of visible light but transmits infra red rays freely, was used instead. The new infra red plate was slightly faster and somewhat less 'contrasty' than the type 1R plate and required the use of printing paper of one grade higher contrast. This made no practical difference.

The range of sensitivity of infra red sensitive plates extends to 1100 micromicrons with maximum sensitivity at 800 micromicrons. According to Hardy and Muschenheim the most penetrating infra red wave length is 1200 micromicrons. A bright tungsten fila-



Fig 1 a, left, H R, aged 23 years, white, nulligravida, not pregnant Infra-red photograph taken on third day of menstrual period b, Same subject Not menstruating Infra-red photograph taken 20 days after beginning of last period



Fig 2, left M M, aged 33 years, white, primipara, not pregnant Only pregnancy occurred 7 years ago Infra-red photograph taken on the fourth day of menstrual period

Fig 3 P P, aged 25 years, white, nulligravida, not pregnant Patient at sterility clinic of Free Hospital for Women Infra-red photograph taken 25 days after beginning of last menstrual period

It is within the realm of speculative possibility that hormonal or vasomotor changes accompanying pregnancy can effect dilatation

of the veins We have noted, for example during other studies in this clinic that the veins of pregnant women respond to vene-

compare these pictures with those taken in a standing position

In photographing the subject the distance from the camera to the subject was adjusted so that the area to be photographed filled the negative. This distance therefore varied slightly with the size of the subject. The lights were placed 2 feet to each side of the camera and were directed so as to give as flat illumination as possible since the emphasis of body contours was not desired. Exposures of 3 seconds at  $f$  16 were made but if the subject was unsteady or could not control her breathing an exposure of  $\frac{1}{2}$  second at  $f$  45 was used. For the occasional ordinary photograph made for purposes of comparison Wratten and Wainwright panchromatic plates were used with the same camera and lights. For these the exposure was 2 seconds at  $f$  32.

#### OBSERVATIONS

In the study of the finished prints the following observations were made:

No changes occurred in the superficial veins of non pregnant women during the menstrual cycle (Figures 1, a and b).

There was considerable individual variation among both pregnant and non pregnant subjects. It was not possible to tell from an isolated picture whether or not the subject was pregnant since some of the non pregnant subjects showed a more marked venous pattern than did some of the pregnant subjects. Compare Figures 1, 2, and 3 with Figures 4, d, and 6, e.

There were no demonstrable differences between the changes in the venous patterns of normal pregnant women and those of pregnant women with organic heart disease or toxemia.

There is an increase in the prominence of the veins of the breasts early in pregnancy, noticeable at the third week and very definite at the eighth week. At the time of the first noticeable increase in the veins there is also a noticeable increase in the size of the breasts. The increase in prominence of the veins of the breasts progresses to term and is maintained after delivery during lactation. This accompanies the increase in the breast size. After the cessation of lactation with involu-

tion of the breasts, there is a diminution in the prominence of the veins (Figs 4, 5 and 6).

There is an increased prominence of the abdominal venous pattern first noticeable at about the fifth month when there is obvious enlargement of the abdomen. This prominence of the abdominal venous pattern progresses parallel to the enlargement of the abdomen until delivery. There is an abrupt diminution or in some cases complete disappearance of the abdominal pattern after delivery (Figs 4, 5, and 6).

It is not possible to state from the appearance of the veins whether or not the subject is a primigravida or a multigravida. Individual variations among primigravidae or multigravidae are as marked as the variations between primigravidae and multigravidae. Non pregnant women may have more prominent venous patterns than pregnant women. Compare Figures 3 and 6, d.

Definite changes are limited to the venous pattern of the anterior trunk. Slight and inconstant changes or no changes at all were found on the posterior trunk or the anterior and posterior surfaces of the legs. The depth of the superficial veins of the posterior trunk precludes satisfactory pictures of them.

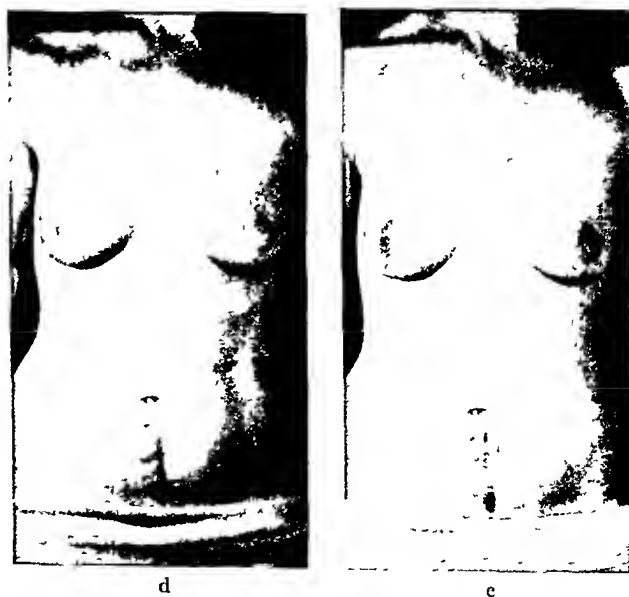
There is a marked dissimilarity of venous pattern among all the subjects photographed. The individual subjects among the illustrations show a wide variety of pattern.

#### EVALUATION OF STUDY

In the explanation of the changes noted in this study several factors must be considered. From the fact that there is no constant detectable change and in most cases no change at all in the veins of the lower extremities as pregnancy advances it seems unlikely that venous stasis is responsible since one would expect stasis to be most marked in the veins of the legs for while the venous pressure in the upper extremities remains within normal limits during pregnancy (2) the femoral venous pressure has been shown to be definitely increased (1). Probably whether or not the superficial leg veins become distended depends considerably on the competence of their valves. Certainly the increase of varicosities during pregnancy is incontestable.



Fig 5, a K C, aged 26 years, white, primigravida Pregnancy complicated by rheumatic heart disease with mitral stenosis and insufficiency Infra-red photograph taken June 4, 1936, 26 days before delivery by cesarean section, which was done at term b, Same subject Twenty-three days following section Infra-red photograph taken July 23, 1936 c, Same subject Forty-four days following section Still lactating Infra-red photograph taken August 14, 1936 d, Same subject Seven months following section, 4 months following cessation of lactation Infra-red photograph taken January 28, 1937 e, Same subject Panchromatic photograph taken January 28, 1937, for comparison with Figure 5, d



It is a common clinical impression that the veins in general, and particularly in the arms where they are most frequently observed, seem "fuller" during pregnancy, and we cannot disagree despite the failure of this study to provide graphic proof thereof One would expect the venous blood content to increase, since the general circulating blood

volume increases considerably (9) The cross section of a normal vein is an ellipse the long axis of which is parallel to the skin surface (3) Distention, therefore, would tend to produce a more circular cross section, which, while it would reduce the apparent diameter of a vein, would at the same time make the skinward surface more superficial If, in addition,



a



b



c



d



e



f

Fig 4 a T. T. aged 29 years nulligravida white not pregnant Patient at sterility clinic of Free Hospital for Women Last menstrual period October 20 1936 Infra red photograph taken November 6 1936 b Same subject Still not pregnant Last menstrual period November 12 1936 Infra red photograph taken November 20 1936 c Same subject About 3 weeks pregnant Last menstrual period December 6 1936 Infra red photograph taken January 8 1937 d Same subject Eight weeks pregnant Infra red photograph taken February 11 1937 e Same subject Twenty five weeks pregnant Infra red photograph taken June 16 1937 f Same subject Five and one half months post partum Infra red photograph taken February 15 1938

puncture by collapse or constriction much more frequently than in the non pregnant If such an explanation were to account for the

observed changes over the breasts and abdomen, it would disagree with the lack of such changes elsewhere

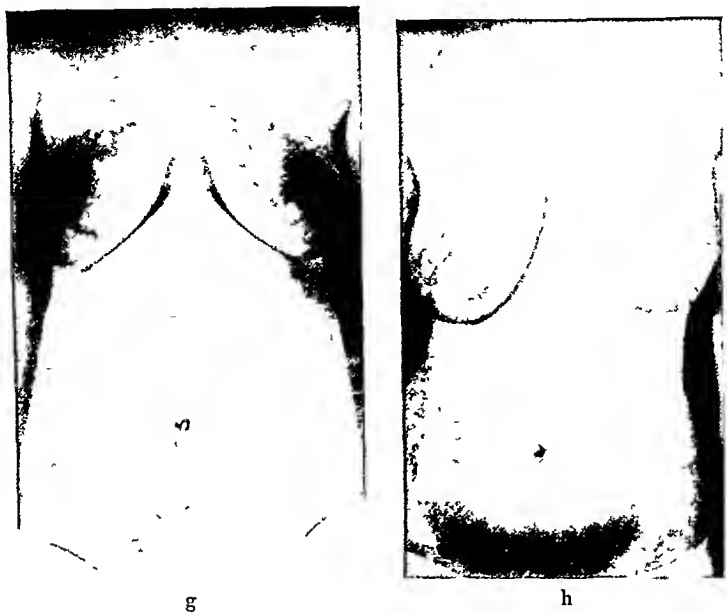


Fig 6, a C M, aged 19 years, white, primigravida, first pregnancy ending in miscarriage at 5 months 1 year ago Not pregnant at this time Last menstrual period December 21, 1936 Infra-red photograph taken December 22, 1936, on second day of period b, Same subject Now about 4 weeks' pregnant Infra-red photograph taken January 30, 1937 c, Same subject Panchromatic photograph taken January 30, 1937 Note lack of venous detail d, Same subject About 8 weeks' pregnant Infra-red

photograph taken March 1, 1937 e, Same subject Eleven weeks' pregnant Infra-red photograph taken March 20, 1937 f, Same subject Nineteen weeks' pregnant Infra-red photograph taken May 15, 1937 g, Same subject Thirty-four weeks' pregnant Infra-red photograph taken August 28, 1937 h, Same subject This infra-red photograph was taken February 12, 1938, 4½ months after delivery, when the patient was still lactating



Fig 7, a, left S S, aged 41 years, colored, nulligravida, not pregnant Multiple leiomyomas of the uterus enlarging abdomen to the size of a 6 months' pregnancy Infra-red

photograph taken day before operation. b, Same subject Infra-red photograph taken 2 weeks following hysterectomy



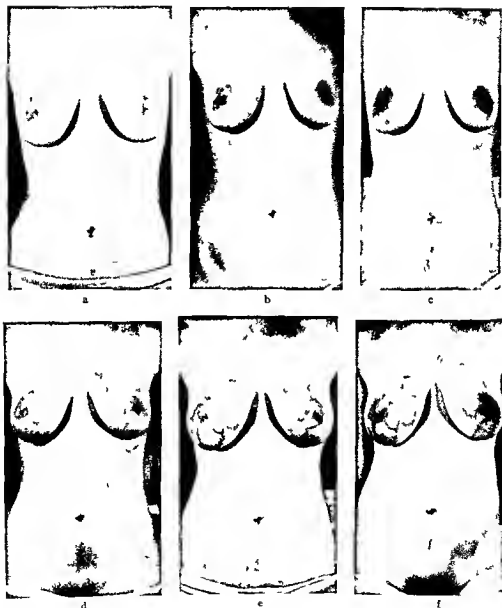


Fig 6

the circumference of the vein alters in response to anatomical or functional changes in its wall, a third factor may be introduced. A photograph, of course, shows only two dimensional changes in the veins, and actual alterations may be present which remain undetected. The impression one has as he studies

a series of pictures of the same subject showing the progressive increase of prominence of the veins to term is not so much that they appear to grow larger but rather that they seem to become progressively blacker, more obvious, and less obscured by overlying tissue. After delivery and after lactation has ceased they

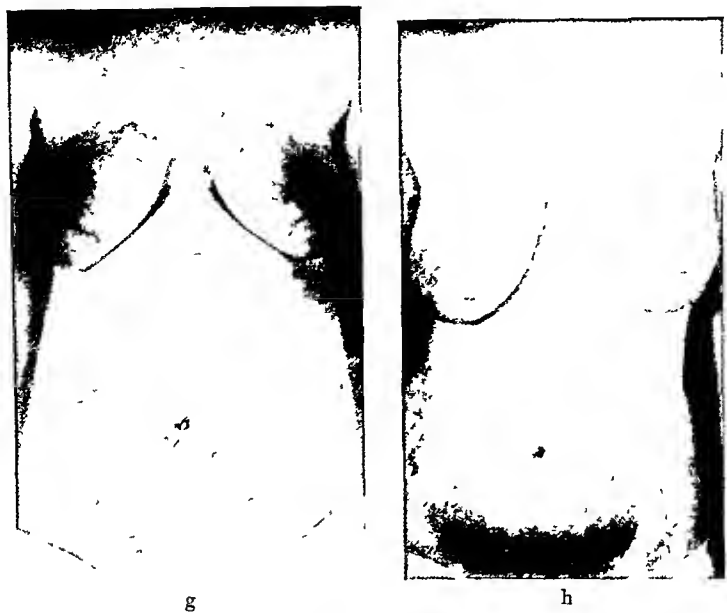


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photograph taken day before operation b, Same subject Infra-red photograph taken 2 weeks following hysterectomy

appear to become again obscured by intervening tissue

We believe that changes in the depth of the superficial veins over the abdomen and breasts play a large part in their photographic prominence during pregnancy and lactation. On the abdomen this is due to stretching of the skin by the protruding uterus, and, similarly, on the breasts by the increased volume of breast tissue. It will be noted that the appearance of prominent veins parallels the enlargement of the uterus and breasts. It appears likely that the large fibroid of the subject shown in Figure 7, a and b, was stretching the abdominal skin sufficiently to bring out the veins in the pre operative picture. It is also probable that the breast and abdominal veins become prominent partly because of a relatively greater blood content than of veins elsewhere in the body. In the case of the breasts this may be attributed both to a functional increase of circulation and to some interference with venous return into the subclavian axillary system due to the effect of the heavier more pendulous breasts, and in the case of the abdominal veins due to increased femoral venous pressure affecting the epigastric system.

An incidental observation made in this study was that the venous pattern of each subject differed from all the rest. It is suggested that this difference could be made the basis of a system of identification which might be a useful addition to such procedures. Alteration of the whole superficial venous pattern by surgery or by the injection of sclerosing substances would be a possible but a dangerous and painful procedure. The pattern of the superficial venous system should

show almost as much variation as is found in the ridges of the fingertips

#### CONCLUSIONS

1 Pregnancy is accompanied by definite, photographically demonstrable changes in the prominence of the superficial venous pattern of the anterior thorax and abdomen. Similar changes do not occur in the rest of the superficial venous system.

2 An isolated photograph of the veins gives no evidence as to whether or not the subject is pregnant, or as to her parity.

3 Similar changes do not occur as a result of the various phases of the menstrual cycle.

4 The changes in the prominence of the veins are principally due to the stretching and thinning of the overlying tissues. It is probable that an increase in blood content, and, in the case of the breasts, of physiological hyperemia contribute to the effect.

5 The same type of change occurs in pregnant women with organic heart disease or with toxemia as occurs in normal pregnant women.

6 The usefulness of the peripheral venous pattern as an aid to identification is suggested.

#### REFERENCES

- 1 BURNELL C S *Am J M Sc* 1938 195 1
- 2 COHEN M E THOMSON K J *J Clin Invest* 1936 15 607
- 3 EDWARDS E A *Anat Record* 1936 64 369
- 4 HARDY J D and MISENERHEIM C J *J Clin Invest* 1936 15 1
- 5 HELWICH OTMAR *Practical Infra red Photography* The Fountain Press London
- 6 MASSOUST L C *Surg Gynec & Obst* 1936 63 86
- 7 IDEM *Radiography & Clin Photography* 1934 10 4
- 8 THOMSON K J et al (in press)
- 9 THOMSON K J HIRSHEIMER A (1936) *J C H Evans W A* *Am J Obst & Gynec* 1938 36 48

# STUDIES ON THE GROWTH STIMULATING EFFECT OF POTASSIUM NAPHTHALENE ACETATE AND POTASSIUM INDOLE BUTYRATE

JOSEPH K. NARAT, M.D., and GEORGE CHOBOT, Chicago, Illinois

A SEARCH for growth promoting substances has led horticulturists to the discovery of so called phytohormones or auxins which stimulate growth by elongation of cells and their capacity of moving downward in the plants. Further studies showed that two closely related substances, named "auxin A" and "auxin B," were responsible for these effects. Later a third, entirely different substance, named "hetero-auxin," was found to produce the same effects (7). A substance called bios, indispensable for the development of yeast and discovered by Wildiers, is closely related to the vitamin B complex (13, 21). The discovery that several synthetic crystalline products cause growth responses in plants served as the basis for work in this field by Zimmerman and Wilcoxon (22, 23), they demonstrated the property to stimulate plant growth in not less than 53 chemical compounds. At the same time auxin was recovered from the human urine in crystalline form (8). Its genesis remains unknown although theoretically its production by intestinal bacteria, its origin from ingested vegetable foods, or its synthesis by the animal organism must be taken into consideration.

All these observations suggested studies of the effects of phytohormones on the animal organism, particularly so because growth promoting substances may find their application in the treatment of burns, indolent ulcers, etc. and also because their rôle in the origin of malignant tumors is within the range of possibility.

From the numerous compounds investigated by Zimmerman and Wilcoxon, two were chosen for the present study, viz., the potassium salts of naphthalene acetic and indole butyric acids, for the following reasons. Indole acids

are closely related to tryptophane, i.e., are not strange to the animal organism; indole acetic acid can be recovered from the urine and the observation has been made that certain indole compounds occur in carcinomatous tissue in concentrations twice that of normal tissue (8). The naphthalene compounds spread readily causing systemic responses, whereas lanolin preparations of indole butyric compounds tend to induce a local response (22). Thus by the use of the potassium salts of naphthalene acetic and indole butyric acids, both the local and general effects of phytohormones could be investigated. Salts were used as they are less toxic in high concentrations than the same concentrations of the acids; salts are also more soluble in water than the acids (22).

The present phytopharmacological investigation was confined to the study of the effect of the two above mentioned synthetic chemical substances on mammalian general growth and local stimulation of regeneration of skin defects.

## EFFECTS OF POTASSIUM NAPHTHALENE ACETATE AND POTASSIUM INDOLE BUTYRATE ON GENERAL GROWTH

Interest in stimulation of the growth of the mammalian organism is great, as can be evidenced from the multitude of substances and methods used for this purpose, lactoflavin (6), theelin (2), Lu-Jung (11), glucose (10), organic phosphorus compounds (12), spaying (2, 4) may be mentioned as examples.

For each experiment 3 litter mates with approximately the same weight were used. One rat was injected with the potassium salt of naphthalene acetic acid, another with the same salt of indole butyric acid, the third served as control. The experiment was repeated 7 times so that 21 animals were used for this part of the study.

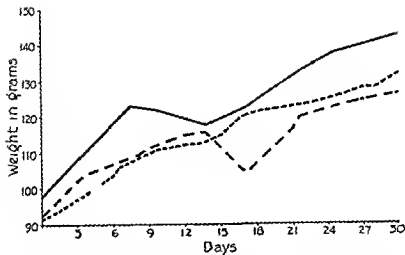


Chart 1: Sample weight chart ——— Control — — — potassium indole butyrate  
potassium naphthalene acetate

To make the effect of the chemicals, if any, more noticeable, the rat with the greatest weight was selected as control, with the idea that the treated rats would catch up in weight with the control animal if the injected substance had a growth promoting effect. Only one reference as to dosage could be found in the literature, namely that of Anderson, Shimkin and Leake (1) who determined the acute intraperitoneal toxicity of some plant growth substances for mice and found that 100 milligrams of indole butyric acid and alphanaphthalene acetic acid per kilogram body weight kills half or more of the animals. Preliminary experiments by the writers showed that both compounds have a cumulative effect. 75 per cent of the calculated lethal dose was distributed over 10 successive days; all the animals died 3 to 7 days later. Apparently the compounds are at least as toxic for rats as for mice as the same dose per kilogram body weight proved to be fatal for rats in spite of the fact that not intraperitoneal but subcutaneous injections, with resulting slower absorption rate were employed. In view of this fact only 25 per cent of the lethal amount was used in the actual experiments, the total amount of 25 milligrams per kilogram body weight was divided into 10 doses, given on 10 successive days. The accompanying sample weight chart

illustrates the results which were approximately the same in each of the 6 groups. The weight of the treated rats never reached the weight of the control animal, the latter gained in course of 30 days 45 grams or 45.91 per cent of the original weight, the rats which received injections of potassium naphthalene acetate gained only 40 grams or 43.47 per cent of the original weight; the corresponding figures for the rats which received injections of potassium indole butyrate were 35 grams or 35.48 per cent. Measurements of the body and tail length did not reveal any marked differences between the treated and untreated animals. Apparently both chemicals under discussion have no appreciable influence on the growth of young rats.

#### EFFECT OF POTASSIUM NAPHTHALENE ACETATE AND POTASSIUM INDOLE BUTYRATE ON LOCAL GROWTH

The fascinating study of regeneration is of great interest to the surgeon who is concerned chiefly with the reparative processes following traumatic or operative injuries of tissues. Innumerable methods and substances have been recommended for stimulation of granulations among the newest the following may be mentioned: thyroid extract (3, 14), hypertonic wet dressings (19), thioacetosol (13), allantoin (5, 17)



Fig 1 Photograph showing the appearance of symmetrical burns immediately after their production



Fig 2 Appearance of burns 18 days after their production Left burn treated with petrolatum, right with potassium naphthalene acetate



Fig 3 Appearance of burns 18 days after their production Left side treated with petrolatum, right with potassium indole butyrate

urea (18), sulphydryl group (16) and cod liver oil (9)

The experiments reported here were confined to the effect of potassium naphthalene acetate and potassium indole butyrate on the healing of artificially produced skin defects. First, an attempt was made to excise approximately equally large portions of the skin from the dorsal region of rats on either side, one to serve as control and the other to be treated with local applications of the chemicals, it was discovered, however, that it is practically impossible to create with a scalpel or scissors skin defects of equal size

A rectangular branding iron, 18 millimeters in diameter, was found to serve the purpose best, the duration of the application of the hot iron and the pressure applied to it were gauged so as to produce a burn of the entire thickness of the skin. The first application of the 5 per cent ointment of the compounds in a lanolin vaseline base was made approximately 15 minutes after the production of a burn, the following applications were repeated at daily intervals for 7 days. The accompanying photographs show that the treated areas were healed 16 days after the production of burns, whereas 22 to 28 days were required for epithelization of the untreated burns. In other words, the

application of the ointments containing salts of indole butyric and naphthalene acetic acids



Fig 4 Appearance of burns 18 days after their production Left side treated with tannic acid, right with potassium indole butyrate

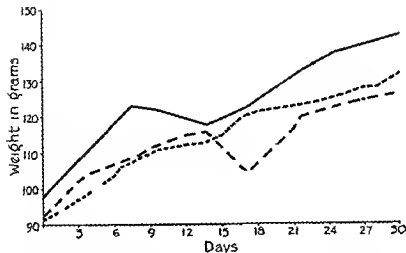


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# BONE SARCOMA

## Factors Influencing the Prognosis

CHANNING C. SIMMONS, M.D., F A C S, Boston, Massachusetts

THE following is a report of the results of treatment of the 47 patients with primary malignant tumors of the long bones, excluding plasma cell myeloma, admitted to the surgical wards of the Massachusetts General Hospital during the 13 year period 1920 to 1932.

This series is a representative group of tumors of this character seen in a general hospital but the results of treatment should not be compared to those obtained in a children's hospital to which patients over 12 years of age are not admitted. It was felt that the figures as to the curability of bone sarcoma obtained by an analysis of the cases in the Registry of Bone Sarcoma of the American College of Surgeons would give an erroneous impression, for physicians are prone to report or register the successful cases and not the failures.

The cases here reported, with the exception of Case 48, have been registered with the Registry of Bone Sarcoma. The specimens from the cases of patients living 5 years have recently been reviewed by Drs S B Wolbach and Tracy B Mallory, pathologists, and by Dr E A Codman in order to bring the pathological classification more closely in line with our present day knowledge.

No case is considered a cure unless the patient is living without evidence of disease 5 or more years since treatment. Three patients died of sarcoma more than 5 years from the date of operation (in 1 instance 12 years), and these cases are considered as failures.

The patients were all seen before it became the custom to study the blood chemistry. At present calcium, phosphorus, phosphatase, and serum protein determinations are made as a routine in all cases. Roentgenograms of the chest were taken before operation to exclude metastases as far as possible.

All of the 47 patients with sarcoma admitted to the hospital during the 13 year period have been followed to date (Table I).

TABLE I — PRIMARY MALIGNANT BONE TUMORS

	Cases
Surgical treatment.	37
X-ray treatment	6
No treatment	4
Total cases (all types)	47

Excluding the 4 cases who refused treatment, the 43 remaining may be divided into three main groups (Table II).

TABLE II — SARCOMA, PATHOLOGICAL TYPES

	Cases
Osteogenic sarcoma	33
Ewing's sarcoma	8
Reticulum cell sarcoma	2

In reviewing the cases, the percentage of 5 year cures was found to be much larger than that usually reported, although it is unlikely that the surgical and radiation treatment is different in this institution from that obtaining in any comparable general hospital.

### OSTEOGENIC SARCOMA

The largest group is that of the osteogenic sarcoma. Three died, without recurrence, of intercurrent disease within 5 years from the date of treatment and are excluded in determining the end-results. One of these died of acute appendicitis 2½ years after operation, 1 following an operation for acute cholecystitis 3½ years after operation, and 1 of a cardiac condition 2 years after operation. Excluding these 3 cases the results of treatment are shown in Table III.

TABLE III — OSTEOGENIC SARCOMA — RESULTS

	Cases	Cures	Per cent
Surgical treatment	28	11	39
X-ray treatment	2	0	0



shortened the healing period by about 35 per cent as compared with the time required in control lesions. Potassium indole butyrate accelerated the regeneration of the skin in a higher degree than potassium naphthalene acetate. The scab remained on the burns an equal time after the application of either salt, but when the scab was slightly lifted 8, 10, or 12 days after the production of the burn it could be seen that larger areas were covered with new epithelium when the first mentioned compound was used (Figs 2 and 3).

For the sake of comparison in 6 rats the burns on the left side were treated with potassium naphthalene acetate and the burns on the right side of the same animals with a brilliant green jelly, the healing rate was approximately identical on both sides. In a similar experiment in which potassium indole butyrate was used, the healing time averaged 2 days less as compared with brilliant green.

In another series of experiments the right burns were treated with potassium naphthalene acetate or potassium indole butyrate respectively, while a 10 per cent tannic acid spray was applied to the left burns on 3 successive days (Fig 4). The healing period was practically identical on the right side, no matter which compound was used. All the burns on the right side healed as an average in 18.3 days while 24.7 days were required for the healing of the burns treated with tannic acid. The observation was made that scabs formed over the burned areas treated with the potassium salts of either of the two chemicals studied were softer, more flexible, and not so firmly adherent to the subjacent tissues as those covering burns treated with tannic acid.

#### SUMMARY AND CONCLUSIONS

1 Under conditions used in this experiment potassium salts of naphthalene acetic acid and indole butyric acid had no effect on the general growth of young rats.

2 A marked stimulating effect of these two chemicals on the regeneration of burned skin

was observed. The healing rate was more accelerated by the salt of the indole butyric acid than it was by the salt of the naphthalene acetic acid.

3 The local growth promoting effect of both chemicals was comparable to the effect of brilliant green jelly.

4 The local healing effect of both chemicals was much more pronounced than the effect of tannic acid.

5 More extensive investigations, including other animals in addition to rats, are desirable to appraise the therapeutic value of potassium naphthalene acetate and potassium indole butyrate in the treatment of burns and other skin defects.

The writers wish to express their sincere gratitude to Dr George Wakerlin for his great help in carrying out this work.

#### BIBLIOGRAPHY

- 1 ANDERSON H K, SHIMKIN M B and LEAKE C D. *Proc Soc Exper Biol & Med* 1936 34 136
- 2 BILLETER O A. *Am J Anat* 1937 60 367
- 3 COHEN M H. *J Am M Ass* 1934 103 183
- 4 FREUDENBERGER C B and HOWARD P M. *Proc Soc Exper Biol & Med* 1937 36 144
- 5 GREENBAUM F R. *Am J Surg* 1936 34 359
- 6 GYORGY P. *Proc Soc Exper Biol & Med*, 1936 35 307
- 7 KOGL F, HAAGEN SMIT A J and ERMLEBEN H. *Ztschr f physiol Chem* 1933 220 137
- 8 KOGL F, HAAGEN SMIT A J and TONNUS B. *Ztschr f physiol Chem* 1933 220 162
- 9 KUEMMEL H. *Deutsche Ztschr f Char* 1936 248 236
- 10 LAVRENIERE G. *Union med du Canada* 1936 65 104
- 11 MINOSHITA T. *Folia Pharmac Jap* 1937 23 March 20
- 12 PERICHANJANZ J and SUDELOVSKAJA O. *Arch internat de pharmacod* 1936 54 349
- 13 PETERS B. *Bio Chem J* 1928 22 445
- 14 PUCKETT H L. *U S Naval Med Bull* 1935 33 510
- 15 REIMANN S P. *J Am M Ass* 1930 94 1369
- 16 REIMANN S P and HAMMETT F S. *Am J Cancer* 1935 23 343 1936 26 554
- 17 ROBINSON W J. *Laryngol* 1935 21 354
- 18 Idem. *Am J Surg* 1936 33 192
- 19 Taylor F W. *Surg Gynec & Obst* 1935 61 623
- 20 WILKINS R. *Cellulose* 1901 18 313
- 21 WILLIAMS R J. *Am Chem Soc* 1927 40 227
- 22 ZIMMERMAN P W and HITCHCOCK A E. *Contrib Boyce Thompson Inst* 1937 8 317
- 23 ZIMMERMAN P W and WILCOXOV F. *Contrib Boyce Thompson Inst* 1935 7 209



Fig 3 Case 44 Osteogenic sarcoma tibia chondral type Male, aged 18 years Trauma 9 months Tumor 6 months Amputation Well 10 years (Figs 4 and 5)



Fig 4 Osteogenic sarcoma tibia chondral type, Case 44 Photograph of specimen (Figs 3 and 5)

rarely extends to the joint cartilage The longitudinal diameter of the defect is also usually greater than the transverse, which is not the case in giant cell tumor Microscopically these tumors are composed of spindle cells with foreign body giant cells about the periphery where bone is being destroyed The

TABLE IV — OSTEOGENIC SARCOMA —  
RESULTS OF SURGICAL TREATMENT

	Cases	Cures	Per cent
Fibrous type	5	5	100
Chondral type	7	5	70
Anaplastic type	16	1	5.5

*Fibrous type* There were 7 cases in this group Five were treated by amputation and all 5 are living The greater portion of the tumors was composed of relatively adult fibrous tissue Two were treated by radiation and died of disease, one 6 and one 7 years after beginning treatment (Figs 1 and 2) These 2 were cases of central sarcoma of the fibrous type erroneously diagnosed by x-ray as giant cell tumors At first glance, the roentgenogram in the central type somewhat suggests a giant cell tumor. The growth is centrally placed, is bone destructive, and causes slight distention of the cortex, but



Fig 5 Osteogenic sarcoma tibia chondral type Photomicrograph of specimen, Case 44 (Figs 3 and 4)



Fig. 1 Case 24 Osteogenic sarcoma fibrous type (Fig. 2) Female aged 21 years. Symptoms for 1 month. Amputation Well 6 years. The roentgenogram is atypical.

By surgical treatment amputation is meant, the entire affected bone being removed when this was possible. In tumors of the humerus disarticulation at the shoulder joint was performed rather than shoulder girdle amputation. In tumors of the lower end of the femur amputation was performed at the level of the lesser trochanter, but, if the shaft appeared to be involved, hip joint amputation was done. There was no operative mortality in this series.

Osteogenic sarcoma may be defined as a tumor originating from the embryonic fibroblast, which, under normal conditions, would differentiate into normal bone. The embryonic fibroblast may form fibrous tissue, cartilage or osteoid tissue.

If we accept the idea just mentioned it is easy to account for the various forms of tissue, i.e., bone, osteoid tissue, cartilage, and adult fibrous tissue, found in the usual bone sarcoma. It was felt that the high percentage of cures obtained in this series might depend on a large proportion of the cases showing a high degree of differentiation of the cells, that is, if



Fig. 2 Photomicrograph of specimen Case 24. The specimen is composed chiefly of cellular fibrous tissue but shows areas of osteoid tissue, cartilage and bone.

the major portion of the tumor was composed of adult tissue, cartilage, or bone, the tumor would prove to be less malignant than it would if composed of undifferentiated fibroblasts.

The cases of osteogenic sarcoma were therefore divided into three main groups which have been termed fibrous, chondral, and anaplastic. The tumors in all of the cases were histologically malignant, and in certain portions tumor giant cells and many cells undergoing mitosis could be found, but in the fibrous and chondral groups adult fibrous tissue or cartilage predominated. In the anaplastic group the greater portion of the tumor was composed of highly malignant cells.

Certain of the pathologists previously mentioned state that some of the cases I have placed in the fibrous and chondral groups probably should be placed in the anaplastic group but the opinions as to which ones should be so placed varied. If the cases in which the patients were treated surgically are divided into the three types above mentioned, namely, fibrous, chondral and anaplastic, the results of treatment are as shown in Table IV.

somewhat older than the patients in the anaplastic group. It must be borne in mind, however, that children under 10 are not often admitted to this hospital. Trauma was mentioned as an etiological factor in 5 of the 7 cases.

It is impossible to distinguish the fibrous type clinically or by x-ray from the other more malignant forms of osteogenic sarcoma; and as far as can be determined, the only reason why the results of treatment were satisfactory is the fact that the major part of the tumor was composed of highly differentiated cells.

*Chondral type* There are 9 cases in this group, 7 of which are suitable for end-result study (Figs 3, 4, and 5). Five are living and well, while 2 are dead of a recurrence of the disease. Pathological examination of all these tumors showed cartilage to be the predominating tissue, but portions of the tumors appeared to be highly malignant. It is often difficult histologically to distinguish between a benign chondroma and a sarcoma.

Clinically, the striking feature of this group was that 5 of the 9 patients were over 50 years of age when the tumor was first noticed.



Fig 10 Case 66 Reticulum cell sarcoma humerus (Fig 9)

RIGHT

Fig 9 Case 66 Reticulum cell sarcoma lower end of the humerus. Male, aged 42 years. Amputation. Local recurrence removed 7 years later. Well 6 years after second operation (Fig 10).

One of these patients probably had Paget's disease of the bones as well, but the history suggests malignant changes occurring in a previously benign tumor. This is known to have occurred in 2 instances. In Case 49, a cure, the patient had a benign chondroma removed three times. Some time after the third removal it recurred, grew rapidly, and at operation proved to be sarcoma. Comparing the specimen removed at the last operation with those removed previously, the character of the growth had changed. In another case, a chondroma had been removed 13 years previously, and the patient considered himself well during the interval. The growth then recurred and amputation was performed, but the patient died a year later of lung metastases.

The roentgenograms in these cases showed in most instances nothing characteristic that



Fig 6 Case 8 Osteogenic sarcoma Anaplastic type (Figs 7 and 8) Male aged 17 years Trauma 1 year pain 4 months tumor, 3 months curetted 2 months Amputation Well 8 years



Fig 7 Case 8 Photograph of specimen (Figs 6 and 8)

diagnosis of osteomyelitis 3 months prior to amputation

The average age of the patients in this group was 22 years, and varied between 16 and 38, that is, as a group, the patients were

presence of a few foreign body giant cells may lead to the erroneous diagnosis of giant cell tumor unless this is borne in mind. That the central fibrous type of osteogenic sarcoma is of low malignancy or radiosensitive is suggested by the fact that the 2 patients treated by x ray lived for several years before showing evidence of lung metastases. One of the cured cases in which amputation was done was of this character. I have seen another similar case, not in the series, in which amputation was performed, and the patient is living and well over 5 years after operation.

Five of the 7 were of less than 6 months' duration from the first symptom to the initiation of treatment, one 9 months, and one 12 months. In one of the cured cases the patient had been subjected to curettage under the



Fig 8 Case 2 Osteogenic sarcoma Anaplastic type (Figs 6 and 7)

but no evidence of metastases. When metastases occur they are usually seen in the lymph nodes or soft parts rather than in the lungs, although the latter may be involved. When a tumor of this type is primary in the lymph nodes it runs a relatively short course, 2 to 3 years, to a fatal termination, but when primary in the bone it appears to be relatively non-malignant, although in the light of the history of these 2 cases there is apparently the possibility of a late recurrence. This might be considered another manifestation of the disease and not a true recurrence. In the 2 cases in this series the tumors were situated in the humerus, 1 in a 12 year old girl and 1 in a 42 year old man. Shoulder joint amputation was performed in both instances. The girl died 12 years later with a tumor of the femur. Unfortunately no history, x-ray, or biopsy report of this second tumor is available. The man had a massive local recurrence in the soft parts about the shoulder 7 years after amputation. This was excised and the operation followed by x-ray therapy. The patient is well today, 7 years after removal of the local recurrence and 14 years after the amputation.

These tumors are radiosensitive, but Parker and Jackson found that with the exception of the case here reported, all but 1 case in which amputation was performed were living over 5 years, while of those treated only by radiation, all were dead, or, if living, showed definite evidence of disease.

It would appear that Parker and Jackson have been able to distinguish a type of primary bone tumor, not previously recognized, which pursues a definite clinical course not in any way resembling that of an osteogenic sarcoma. It is probable that certain of the reported cases of cures of both Ewing's tumor and osteogenic sarcoma were unrecognized tumors of this character.

#### EVALUATION OF STUDY

From this analysis it would appear that the prognosis in a series of cases of malignant bone tumors taken consecutively as they are admitted to a general hospital, is far from hopeless when they are treated by radical surgery. Although all the cases reported were considered malignant, the time at which

metastases occurred obviously varied. In reviewing the specimens, the tumors in which relatively adult tissue, such as fibrous tissue and cartilage, predominated did not form metastases for some time after the tumor was noted clinically, and the patients were therefore cured by complete removal of the growth.

The time element, that is the duration of the tumor before treatment, undoubtedly has a bearing on the result in a given case, although if these cases are considered as a group, this is not so. The prognosis appeared to be worse in the cases of short duration, but it was found that the duration in the majority of the tumors of low malignancy, in which cures were obtained, was appreciably longer. This same relation between duration of disease and prognosis has been found to obtain in studying groups of cases of cancer of the breast. There is only 1 case of short duration in this series, a 7 year cure, and this occurred in the family of a physician. There had been symptoms for about 3 weeks, although the roentgenogram suggested a tumor of longer duration, and operation was performed within 24 hours from the time the diagnosis was suspected.<sup>1</sup>

It is difficult to obtain the consent of the patient or the parents to amputate for a small tumor, and they will grasp at any form of treatment first that does not sacrifice the extremity.

The value of pre-operative radiation treatment is problematical. It was not employed in any case in this series, for the time element was considered more important. Radiation undoubtedly affects the cells profoundly but apparently does not destroy the tumor. There is no instance of cure by radiation alone of a proved case of osteogenic sarcoma in the Registry.

The surgical procedure adopted whenever possible was a biopsy performed with a tourniquet on the limb, frozen section examination of the tissue removed, and immediate amputation if the tumor was reported to be sarcoma. A suction biopsy done some

<sup>1</sup>Since this paper was submitted for publication Case 24 (Registry of Bone Sarcoma No. 1254) presented evidence of two metastases in the lung, 7 years after operation. These were successfully removed by lobectomy. The histology of the metastases was the same as that of the original tumor.



Fig 11 Registry of Bone Sarcoma No 1092 This shows the characteristic appearance of one form of reticulum cell sarcoma and is to be compared with Figure 9 The case is not included in this series

would serve to distinguish this type from other forms of sarcoma Three of the tumors were in the upper end of the tibia, 2 in the metatarsals, and 1 each in the radius, humerus, femur, and scapula Trauma was mentioned as an etiological factor in the history in 4 of the 9 cases In no case in this group was the duration of the disease from the first symptom to operation less than 4 months, and in 5 instances it was over a year In other words, the tumors were of slow growth and metastasized late in the course of the disease

**Anaplastic type** There were 21 cases in this group Four refused treatment and 1 died of intercurrent disease (operative death following cholecystectomy) and have been excluded in determining the end results of treatment Of the 16 remaining only 1 is living (5.5 per cent cures) (Figs 6, 7 and 8) In all these cases the major portion of the tumor was composed of anaplastic cells although small areas of adult cartilage bone, and fibrous tissue could be found Twelve of the patients were under 22 years of age, and 4 cases were over 60, but in the latter group the disease was secondary to Paget's disease

of the bone Twelve of the 21 tumors arose about the knee joint

Excluding the cases with Paget's disease, in 10 of the 16 patients, the symptoms were of less than 3 months' duration when the patients sought treatment, while in 2 cases, 1 a cure, symptoms had been present 4 months The average duration of the disease from first symptom to operation was considerably less than in the two forms previously discussed, yet the tumors had obviously formed metastases when first seen

The roentgenograms were characteristic of a malignant bone tumor and all showed bone destruction and new bone formation in varying amounts There was no way clinically, however, to differentiate this form from that in which cartilage or adult fibrous tissue predominated

#### EWING'S SARCOMA

There are 8 cases of Ewing's sarcoma in the series All died of disease Four were treated by amputation and 4 by x ray, the latter cases with marked temporary improvement

#### RETICULUM CELL SARCOMA

There are 2 cases of this type of tumor in the series, but I have seen others and there are several in the Registry collection Most of the cases in the Registry have been placed under the heading "malignant disease of bone, unclassified" Recently Parker and Jackson have reviewed these cases, with others of their own and believe the growths are identical with the so called reticulum cell sarcoma of the soft parts Their paper appears elsewhere in this issue These tumors run a different course from that of osteogenic sarcoma In the early stage of the disease the symptom common to all malignant bone tumors is present that is, pain unrelieved by rest Later a tumor is noticed which grows rapidly, and although it may attain considerable size the general condition of the patient remains excellent (Figs 9 and 10) In the roentgenogram the tumors originate in the medulla, which in the early stages has a mottled appearance (Fig 11) and may be confused with osteomyelitis or Ewing's sarcoma Later there is bone destruction and a bulky tumor

Case 47, Registry 1217. Female, aged 68 years. Scapula Trauma, 11 months, pain, 6 months, tumor, 3 months, excision of scapula Pathology. osteogenic sarcoma chondral type Local recurrence in 11 months Excised Well 5 years after second operation

Case 48, not registered Female, aged 59 years Lower end of radius Trauma, 5 years, followed by pain and swelling Three minor operations performed with no improvement Amputation Pathology osteogenic sarcoma chondral type Well 5 years A probable example of a chondroma assuming malignant qualities

Case 49, Registry 2133 Male, aged 15 years Upper end of tibia Tumor, 5 years, no trauma, removed 3 times by wide local excision but recurred Pathology chondral type Well 5 years A typical example of a benign chondroma changing its character and becoming malignant

Case 65, Registry 63. Female, aged 12 years Upper end of humerus Tumor, 3 months, curetted for osteomyelitis Amputation Pathology probable reticulum cell sarcoma Said to have died 12 years later of a tumor of the lower end of the femur Unfortunately we do not know the character of the tumor of the femur It was probably another manifestation of the disease and should not be considered as a true recurrence

Case 66, Registry 564 Male, aged 44 years Lower end of humerus Pain, 10 months, fracture, 5 months, tumor, 2 months Amputation Pathology reticulum cell sarcoma Recurrence in soft parts about shoulder 7 years later Excised Radiation Pathology, same Well 6 years after second operation

I do not consider this man necessarily cured, for I think these tumors belong in the lymphoma group and later manifestations of the disease may develop



time prior to operation might disseminate the disease. Two of the cured cases of osteogenic sarcoma, however (Cases 7 and 8) had been cured some time before amputation under the erroneous diagnosis of osteomyelitis, and one case of reticulum cell sarcoma (Case 65) had also been explored.

There is no way by which the various types of osteogenic sarcoma may be distinguished clinically with any degree of accuracy, although occasionally the character may be suspected. In individuals over 50 the tumor is usually secondary to Paget's disease of the bone (4 cases in this series) or of the chondral type (5 of 9 cases). In the chondral type it usually represents malignant changes occurring in a small pre-existing island of cartilage.

The 8 cases of Ewing's sarcoma are all dead. My experience with this tumor is limited to 26 cases, some patients being treated by radiation and some by operation but all are dead. There are a few 5 year cures, however, in the Registry collection.

The most interesting group, although small is that of the primary reticulum cell sarcoma of bone. The nature of this disease shows a destructive process in the medulla in the epiphyseal end of the diaphysis, often multiple small areas with no new bone formation. The picture is suggestive of other forms of malignant lymphoma of bone. Later there is a bulky tumor destroying the bone, but the patient remains in excellent physical condition. These tumors are radiosensitive but from the data at hand the results are more satisfactory following radical surgery than following radiation treatment.

#### CONCLUSIONS

1. The prognosis in a series of consecutive cases of osteogenic sarcoma is not as poor as is generally believed if the tumors are removed by radical surgery.

2. Of 28 cases of osteogenic sarcoma in which amputation was done, 11 patients 39 per cent, are living without disease 5 or more years after operation.

3. The prognosis depends more on the amount of differentiation of the cells comprising the major portion of the tumor than on any one other factor.

4. If the tumor is composed in large part of adult fibrous tissue or cartilage, the prognosis is better than if the cells show marked anaplasia.

5. In 5 cases in which fibrous tissue predominated, patients were treated by amputation. All are well (100 per cent).

6. Of 7 cases in which amputation was done and in which cartilage was the predominating tissue, 5 patients are well, 70 per cent.

7. Of 16 cases in which amputation was done and which may be placed in an anaplastic group 1 is well (5.5 per cent).

8. Two cases of reticulum cell sarcoma in which amputation was done are reported. One patient is well 14 years later, and 1 died 12 years later of a tumor of another bone, the character of which was not determined.

9. Of 8 cases of Ewing's sarcoma, 4 patients were treated surgically and 4 by radiation. All patients died of the disease.

#### ABSTRACTS OF HISTORIES—CURED CASES

Case 2 Registry 407. Male aged 31 years. Lower end femur. Pain, 1 year. Trauma 9 months. Tumor 3 months. Amputation. Pathology sarcoma fibrous type. Low malignancy. Well 10 years.

Case 5, Registry 214. Male aged 38 years. Lower end femur. Trauma 16 months, tumor 4 months. Amputation. Pathology sarcoma fibrous type. Well 6 years.

Case 7 Registry 312. Male aged 18 years. Lower end femur. Trauma 4 months. Cured for osteomyelitis 3 months. Amputation. Pathology sarcoma fibrous type. Well 14 years.

Case 8 Registry 344. Male aged 17 years. Upper end tibia. Trauma 1 year. Pain 4 months. Tumor 3 months. Cured for osteomyelitis. Amputation. Pathology highly malignant sarcoma. Well 8 years.

Case 23 Registry 945. Male aged 16 years. Tumor upper end of tibia 10 months. No trauma. Amputation. Pathology osteogenic sarcoma chondral type. Well 7 years.

Case 24 Registry 1254. Female aged 21 years. Shaft humerus. No trauma. Pain 1 month. Amputation. Pathology sarcoma fibrous with cartilage. Low malignancy. Well 6½ years.

Case 28 Registry 1572. Female aged 16 years. Lower end of femur. Probable trauma. Tumor 4 months. Amputation. Pathology sarcoma central fibrous type. Low malignancy. Well 5½ years.

Case 44 Registry 945. Male, aged 18 years. Upper end of tibia. Trauma 9 months. Tumor 3 months. Amputation. Pathology osteogenic sarcoma chondral type. Well 6 years.

# CLINICAL SURGERY

FROM THE JAMES BUCHANAN BRADY UROLOGICAL INSTITUTE

## A NEW RADICAL OPERATION FOR CARCINOMA OF THE BULBOUS URETHRA

### A New Use for the Penis

HUGH H. YOUNG, M.D., F.A.C.S., Baltimore, Maryland

THE case of carcinoma of the bulbous urethra which is described here seems worthy of report, inasmuch as it furnishes a completely radical procedure without mutilation or stricture. In this patient, after an extensive block dissection, a great urethral hiatus was eliminated by telescoping the penis backward and suturing it to the triangular ligament.

#### CASE REPORT

BUI 26189, J. B. D., a man, aged 59 years, was admitted September 21, 1937, complaining of a gradually increasing lump about the urethra in the region of the scrotum and perineum of 2 months' duration. The family history was negative, and the past history was non-contributory. He had had acute gonorrhea 40 years ago. This disappeared under local treatment, but subsequently he had prostatitis, for which he was treated 20 years ago. His physician reported that he had not had a prostatitis recently and that his Wassermann test was negative. His sexual powers were normal, and several months before admission he was having intercourse about every 10 days. Three years ago, at the age of 56, the patient noticed some hesitancy at the beginning of urination, and a decrease in size of stream. A diagnosis of urethral stricture was made, and he was treated by the passage of sounds, beginning with No. 18 F. These dilatations were continued at intervals of about 5 weeks for 3 years, a No. 29 F. sound being frequently introduced. These treatments kept the urethra dilated so that urination was quite satisfactory until about 2 months ago, when, following the passage of a No. 29 F. sound, he noticed marked discomfort in the urethra. On palpation the patient then felt a pea-sized lump along the urethra in the perineum. After that the lump gradually increased in size until it reached about an inch or so in length. He was treated by diathermy with no reduction in the size of the indurated area. After the onset of the induration there was a complete cessation of erections and libido. Recently it had been found impossible to pass a sound of the usual size, and difficulty in voiding urine had returned.

The patient was referred by Dr. William R. Barron, Columbia, South Carolina, who had found a markedly indurated area around the urethra which he considered suspicious. The patient was voiding urine without much difficulty or frequency and was enjoying excellent health, but had had no libido, erections or coitus for several

months. He complained of a hard mass around the urethra, back of the scrotum, which gave him no pain. There was no history of hematuria or urethral discharge.

On examination the penis and scrotum appeared normal (Fig. 8). Palpation along the urethra revealed a markedly indurated area around the urethra beginning at the penoscrotal junction and extending back for a distance of about 5 centimeters. The mass was hard, slightly irregular, somewhat fixed, about 2.5 centimeters wide, and apparently entirely within Colles' and Buck's fasciæ. The skin and subcutaneous tissues and the scrotum and its contents were not fixed to it. The posterior part of the bulb and crura of the penis were negative. The mass, about 5 centimeters in length, was not adherent to, and apparently did not involve, the symphysis pubis or the ischiopubic rami. Its location is shown in the clinical sketch (Fig. 1 and also in Fig. 2, 1). No enlarged glands were found along the penis, in the perineum, or in the groin on either side. The testicles, epididymides, vasa, and veins were negative. On rectal examination the anal sphincter and rectum were found to be negative. The prostate was about normal in size, shape, and consistence. The seminal vesicles were slightly indurated. The membranous urethra was soft and normal in size. With the finger in the rectum and the thumb on the perineum one found slight enlargement and a little thickening of the bulb at or near its posterior limit. A short distance below this point an indurated mass was felt which surrounded the urethra and rapidly became wider and thicker, apparently involving much of the bulb and urethra. The mass was movable, not adherent to the lateral structures of the perineum, and stopped abruptly near the penoscrotal junction. Bougies à boule and catheters introduced in the urethra met with an impassable obstruction within the scrotal portion of the urethra where the hard mass was palpable. It was so dense that no effort was made to pass filiforms, followers, or sounds, as the diagnosis of carcinoma seemed evident.

The urine was clear, acid, specific gravity, 1.020, no albumin, sugar or white blood cells were present, and only 1 or 2 red blood cells per high powered field. No infection was seen. The phthalein test showed an appearance time of 8 minutes, and half hourly outputs of 56, 20, 12, and 4 per cent, two hour total 92 per cent. The blood urea was 28 milligrams per cent; hemoglobin 100, leucocytes, 7,350. The diagnosis was coronary arteriosclerosis, heart disease, a subsiding upper respiratory infection, and malignant tumor of the urethra. As a portion of the bulb and urethra back of the tumor were apparently free from invasion, the possibility of a radical operation seemed excellent.

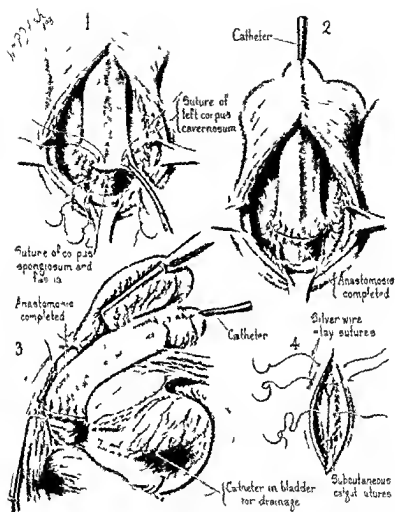


Fig. 7. Completion of approximation by suturing fasciae covering corpora cavernosa and spongiosum with bulb and crura. 3. Lateral view showing extent to which penis was drawn backward and telescoped to fill defect and provide continuity of urethra. Catheter in place for drainage. 4. Closure of wound. BUI 26189.

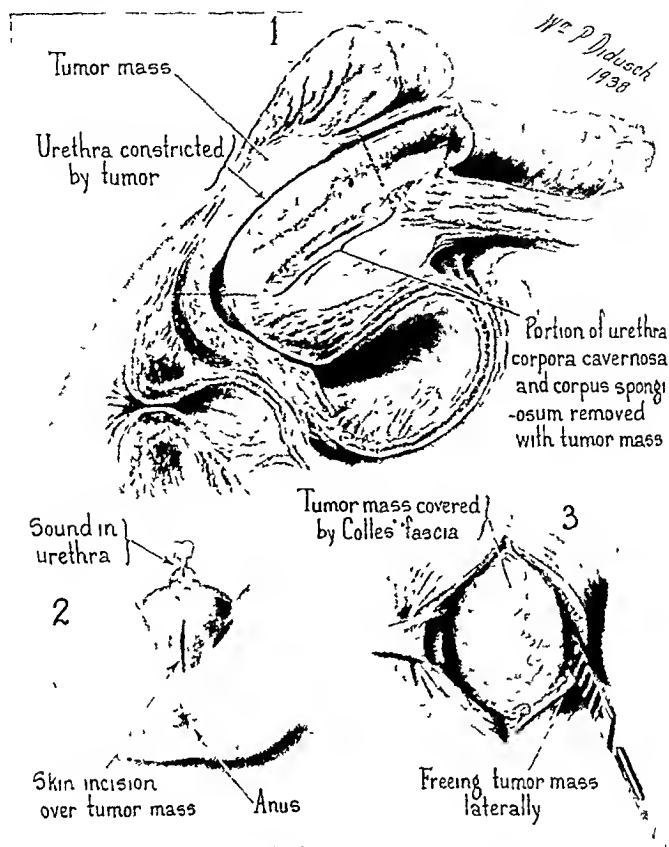


Fig 2 1, Schematic sectional view showing location of carcinomatous mass involving corpora cavernosa and spongiosum. Dotted lines indicate extent of resection. 2, Perineal incision extending up on scrotal portion, subcutaneous blunt dissection exposing Colles' fascia. BUI 26189

tance of about 9 centimeters between the stump of the urethra behind and the section of the urethra and cavernous bodies anteriorly (Fig 5, 3). The anterior portion had retracted into the depths of the scrotal wound. By grasping the fasciæ with forceps, we found it possible to draw the remaining cavernous bodies of the penis backward without difficulty until they could be made to touch the cut end of the urethra posteriorly (Fig 6, 1). In so doing the penis was telescoped within the penoscrotal pouch until only the glans penis was visible (Fig 6, 1 and 2). Anastomosis of the two cut ends of the urethra was then made with fine 10 day catgut, a continuous stitch being employed (Fig. 6). A catheter was introduced just before closure of the line of urethral sutures. The cavernous tissues and surrounding fasciæ were then drawn together with interrupted sutures of plain

catgut (Fig. 7, 1) some of which were placed in the stumps of the crura on each side, some into the deep structures of the triangular ligament. The anastomosis was easily carried out without tension and seemed entirely successful. It was surprising how easily the penis had been drawn back to be sutured to the triangular ligament (Fig. 7, 2 and 3). The subcutaneous tissues were then drawn together in the median line with interrupted plain catgut sutures, and the skin was closed with silver wire sutures. Examination showed the glans and about 1 centimeter of the shaft of the penis protruding from a pouch at the penoscrotal juncture (Figs 7, 3 and 8). The contrast between the length of the penis before and after operation is shown in Figure 8. The scrotal contents appeared normal. The catheter, which had been introduced, was fastened in the penis with adhesive, the

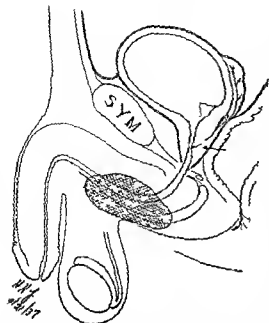


Fig. 1 Clinical chart showing location and size of carcinomatous mass. HUI 26189. Arrow indicates negative prostate; cross hatched area very hard mass around anterior half of bulbous urethra.

Operation was carried out September 22 (by H H V), using avertin gas ether anesthesia. A McCarthy urethroscope was introduced before the operation was started and revealed a slight irregularity and marked narrowing of the urethra in the region of the mass, but no ulceration or projecting neoplastic tissue was visible. With the patient in the position for perineal prostatectomy an incision 6 centimeters long was made in the midline of the perineum just behind the scrotum which was pulled forward (Fig 2, 2). Colles' fascia covering the bulb of the urethra was isolated on each side to the ischiopubic ramus. It was smooth, but beneath it a markedly indurated mass occupying the anterior two-thirds of the bulb and extending up to the scrotal portion of the penis was found (Fig 2, 3). After exposing Colles' fascia, which covered the cavernous bodies, palpation of the mass showed that it was of third degree induration and slightly irregular. There were no areas of softening and nothing suggesting local areas of suppuration or sinuses. It seemed evident that the diagnosis was surely carcinoma but before I began the proposed very radical operation it seemed wise to take a biopsy. An incision was made on the posterior surface of the mass. Colles' fascia and the tissue immediately beneath it did

not appear to be involved, but the scalpel soon encountered the markedly indurated tissues which on cut section gave every evidence of being carcinoma. Nevertheless, a wedge shaped piece (Fig 3, 2) was removed and the wound packed while the operator waited for the report on microscopic examination of the stained frozen section. In 10 minutes the diagnosis "carcinoma" was received and we proceeded to carry out a very extensive radical operation (Fig 3, 2) to remove the mass with its surrounding fasciae and a goodly portion of the cavernous bodies anteriorly, and much of the uninvolved bulb behind. The scrotum was retracted well forward and blunt dissection was continued downward outside the fasciae covering the corpora (Colles' and Buck's) until a point about 2 centimeters below the lower margin of the indurated mass was reached. A clamp was then passed around the cavernous bodies and their fasciae, and a transverse incision was made through the corpus spongiosum and corpora cavernosa (Fig 3, 1) thus the scrotal portion of the penis was completely severed. On examination it seemed desirable to remove more of the cavernous bodies and a second incision was made transversely through them at a point about 1.2 centimeters farther down (Fig 3, 1). (In the drawings, Fig 3, 1 and 2, only this incision is shown.) After the cavernous bodies were divided, the fascia covering them was seized with forceps, and by sharp and blunt dissection they were freed from the structures in front. A suspensory ligament was recognized and divided, and the adhesions to the anterior surface of the pubes and ischiopubic rami on each side were divided close to the bony structures (Fig 4, 1 and 2). The dorsal arteries and veins were divided, bled freely and required ligation, both at the upper and lower end of the dissection. When the mass was pulled outward and the dissection carried backward the crura of the corpora cavernosa were encountered on each side, and divided close to the ischiopubic rami (Fig 5, 1). One could then palpate the urethra as it left the bulb and penetrated the triangular ligament. Below it was a portion of the bulb which was free from involvement for several centimeters behind the malignant mass. A clamp was placed beneath the urethra and an incision was then made through the bulb just in front of its posterior limit (Fig 5, 2). This incision was continued through the urethra at a point about 1 centimeter in front of the triangular ligament (Fig 5, 3). The mass with its surrounding fasciae and uninvolved tissue of the bulb behind and the cavernous bodies below was removed. After all hemorrhage had been carefully arrested inspection showed a dis-

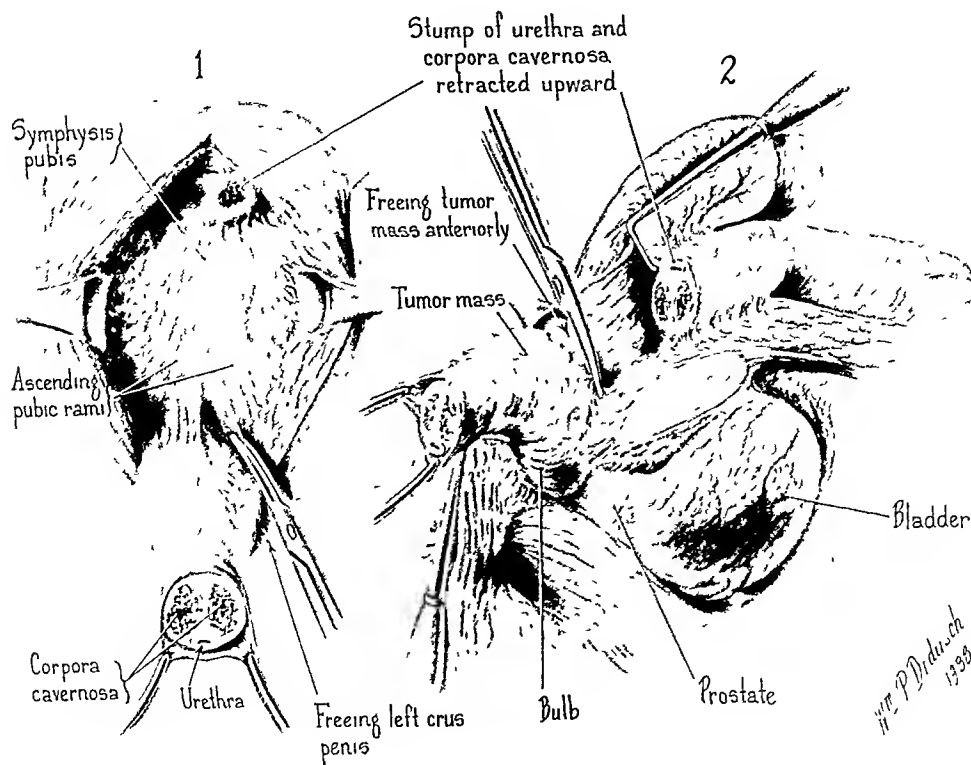


Fig 4 1, Colles' fascia has been cut away from ischiopubic ramus on each side. Suspensory ligament has been divided and mass dissected backward, exposing anterior surface of symphysis and ischiopubic ramus. Penis has retracted into scrotum. 2, Continuing deep dissection. BUI 26189

He had no pain, local or remote. He had not lost weight, and was enjoying excellent health. He had had no erections (but these were stated to have been absent 2 months before operation).

The patient looked well and weighed 175 pounds. The penis was normal in width but very short (Fig 9). The glans measured 4 centimeters wide and 3.5 centimeters long. Above this the shaft of the penis could be followed into a pouch beneath the pubic fat for a distance of 3.5 centimeters. In the median line of the perineum was a narrow scar 7 centimeters in length and with very little induration. On palpation much less tissue than usual was found in the region of the bulb. Far forward, in the region of the scrotum, the cavernous bodies felt about normal in size. Passing backward they became gradually smaller down to the point where the anastomosis was made just below the external sphincter. No bulb and no crura were palpable. There was very little cicatrix at the site of anastomosis and elsewhere

the tissues were soft. There was nothing to suggest a recurrence. No enlarged glands were palpable in either the perineum or the groins. On rectal examination the prostate was found to be negative and no glands were palpable. The patient voided about 500 cubic centimeters of clear urine. No sounds or other instruments were passed.

One year after operation the patient was reported to be well.

#### REPORTED CASES

Primary carcinoma of the male urethra is comparatively rare. In 1923, after reporting 1 case, Kretschmer brought the total number in the literature to 80. In 1931, Lower assembled 112 cases to which he added 3 cases that had come under his personal observation. In 1932, Kirwin, after excluding certain reports, stated that the total number of acceptable cases of carcinoma of the male urethra in the literature was 99. In 1937,

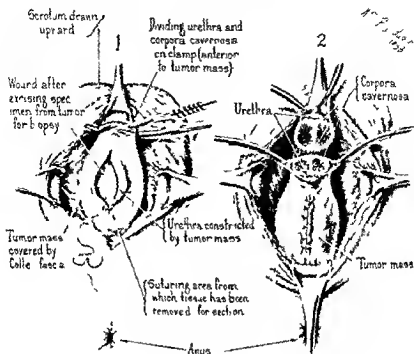


Fig. 3. 1 Section through Colles fascia into indurated mass for biopsy. Incision was closed while waiting for microscopic report (see ). After isolation of root of penis and careful avoidance of penetration of Colles and Buck's fascia a clamp was placed around 3 corpora well up in scrotal portion of urethra which was made visible by firm retraction of scrotum. 2 Division of corpora and beginning isolation of posterior part of penis and prepuce. BU 126159

bladder was washed clean and a drainage apparatus was attached. The operation had not been difficult and was apparently thoroughly radical and satisfactory.

Two specimens were removed at operation, the larger weighing 27 grams and measuring 3.3 by 3.3 by 2.5 centimeters, the smaller which was a transverse section of the three corpora of the penis measured about 1.5 centimeters in thickness. The urethra in the larger specimen measured 3.3 centimeters in length and was surrounded by the tumor. The urethra appeared normal. No nodules or ulceration of the mucosa were visible. Immediately beneath the mucous membrane was found a firm hard nodular mass between the urethra and the corpora measuring 2.5 by 1.3 by 1.3 centimeters. Three sections were taken through the urethra, tumor and corpora for sections.

On microscopic examination of the tissue a squamous cell carcinoma of the urethra was seen. The framework was made up of fairly dense fibrous tissue and scattered throughout this were seen small irregular nests of tumor cells which were characterized by great variation in size, shape and staining characteristics. In the center of many

of these nests were found epithelial cells with varying stages of keratinization. The urethral mucosa was lined with normal transitional cells. Adjacent to it but not involving it was a tumor mass above described. In places the tumor cells were characterized by huge clear cytoplasm and small round pyknic nuclei. One group of these cells was closely packed together without intervening stroma. On the opposite side of the urethra a section of one corpus cavernosum appeared entirely normal.

The catheter was removed from the urethra on the sixth day after operation. Following this the patient voided some urine through the incision but it healed completely in 18 days. There was a marked urethral discharge which soon disappeared. The patient left the hospital one month after operation voiding freely without pain and with excellent control. He had no urethral instrumentation after removal of the indwelling catheter. He was given mandelic acid by mouth because of a urinary tract infection with the *Staphylococcus aureus*. He was advised to continue this on returning home.

On April 21, 1938 the patient returned for observation (7 months after operation). He had had no instrumentation. He voided urine freely in good stream at intervals of 6 hours, night and day and often did not arise at night.

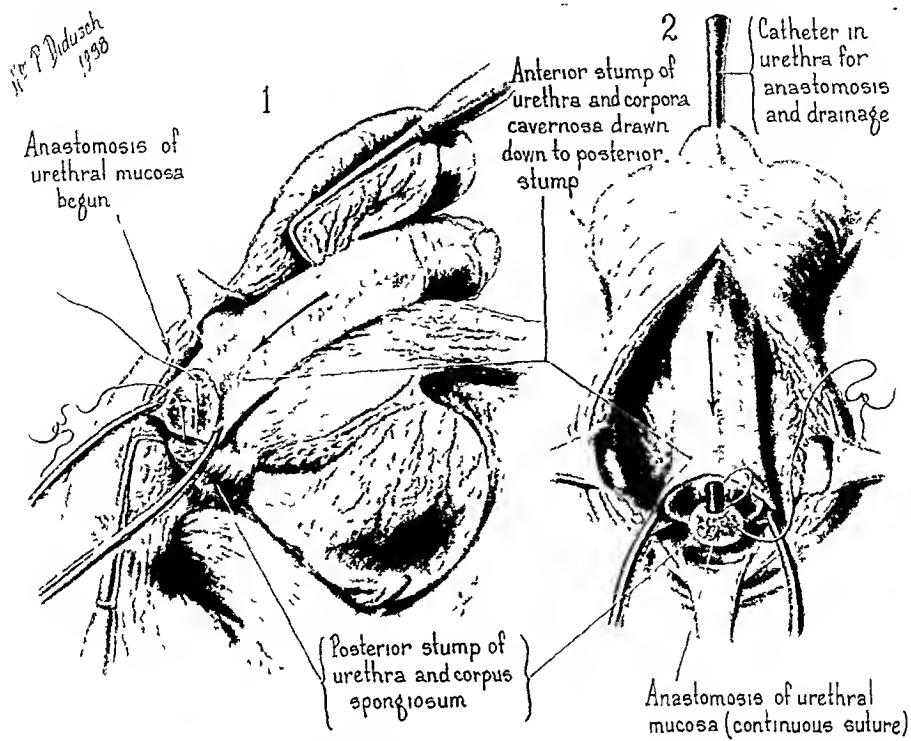


Fig 6 It was found to be easy to draw penis backward so as completely to cover defect and anastomose two ends of urethra and corpora BUI 26189

noma in the intestinal tract, Deetz in the biliary tract, Hallé in the renal pelvis and ureter, Wassermann and Cederkreutz in urethral carcinoma Scholl and Braasch adopted this view and say that Kittel and Kaufmann demonstrated definite epithelioma associated with urethral stricture, but that Thiersch was the first to call attention to malignant transition of these cicatrized areas and to report a case of squamous cell epithelioma developing in a case of long-standing stricture In 1904 Poesner collected 20 cases in the male urethra, in 12 of which urethral stricture had been present Other authors have reported cases in which carcinoma followed traumatism, generally to the perineal urethra. Kretschmer admitted that stricture often led to metaplasia or leucoplacia of the urethral mucosa, but he asserted that carcinoma may produce symptoms of stricture early in its course and lead to an erroneous diagnosis In a paper by Kretschmer we read that since "gonococcal infection of the male urethra is common and carcinoma rare, the gonococcus plays little if any etiologic rôle in the production of this disease"

#### PATHOLOGY

Primary carcinoma of the male urethra has been classified as follows (1) squamous cell, (2) columnar cell, (3) papillary, and (4) adenocarcinoma All authors are agreed that the squamous cell carcinoma is by far the most frequent (in Preiswerk's series of 42 cases, all but one) In Kretschmer's series of 80 cases he found none of the columnar type and considered that the papillary carcinoma, of which he presented a case, was also very rare When adenocarcinoma was found, the origin was thought to have been Cowper's glands in most cases, but it was admitted that a true adenocarcinoma might begin in other peri-urethral glands, although this apparently was extremely rare. In a study made by Young and Davis (1926) it was stated that "metastases in epithelioma of the urethra are usually late Regional metastasis is to the iliac or inguinal nodes, or both If the growth is posterior to the suspensory ligament, there is little chance of metastasis to the inguinal nodes From the urethra lymphatic drainage goes to the external iliac, hypogastric, and sacral groups of nodes so that any of these may be involved In 2 cases



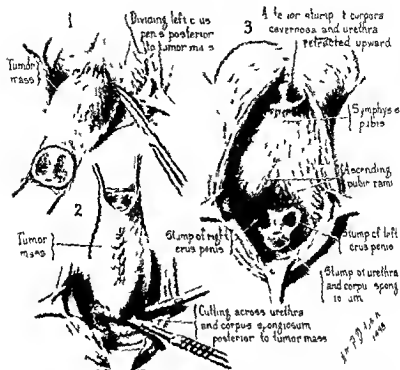


Fig. 5. 1. Left crus being divided. 2. Clamp has been placed in front of urethra just below bulbomembranous junction and bulb is being divided. 3. Large cavity left after removal of urethra and corpus spongiosum with surrounding fasciae intact. Two ends of urethra are about 3 1/2 inches apart (9 cm). Problem was what to do to close external defect. BUL 26149

Harbach added 7 cases which had been collected by McNally and 1 by himself bringing the total number in the literature to 107. In 1938 Hertzmann and Colloff stated that after a very thorough search of the literature they found 143 reported cases many of which had not been mentioned by any authors since the original publication. To this list they added 2 new cases making the total of 145 reported to date. When one considers the number of papers that have been written on the subject the fact that only 145 cases have been reported is sufficient to show the comparative rarity of the disease. At this clinic we have had 84 cases of carcinoma of the penis, but only 5 cases of carcinoma of the urethra.

In the early literature Thaudere was given credit for the first report of carcinoma of the urethra. There was an obstruction in the spongy urethra at a depth of about 1 1/2 inches. The author incised the superior surface of the glans, dissected out the tumor which was the size of a pea from the wall to which it was adherent. Kurwin after

studying the original report decided that, as the patient was a young man and was cured by a small excision of tissue and cauterization, the case could not be accepted as one of carcinoma. The first apparently acceptable case was that of Hutchinson which was presented to the London Pathological Society in 1861 but the first paper of real importance was that of Wassermann, who presented, in 1895, 20 cases in the male 24 in the female and 3 cases in which the lesion was located in Cowper's glands. Since then the literature contains papers by Soubeyran (1902), Lanton (1910), Scholl and Braasch (1922) and the papers by Kretschmer and the others mentioned above to which publications the reader is referred for complete bibliographies.

#### ETIOLOGY

Inflammatory irritation causing metaplastic changes in epithelial surfaces has been cited as the principal etiological factor by numerous writers. Bohm thought that this was the cause of carci-

Kretschmer (1923) reported a case of carcinoma of the urethra in which he had carried out amputation of the penis, transplantation of the urethra to the perineum, and removal of the inguinal glands *en masse*. Similar operations by various authors are to be found in the literature.

Emasculatation has been frequently performed by European surgeons, but no evidence of involvement of the testis is found in any of the reported cases. Lower (1931) reported 3 cases.

His first was a "man aged 58 who suffered injury to the perineum some years previously. Two years before admission he had an acute retention caused, he said, by a cyst of the urethra. The perineal incision had been made. This was followed by fistula. Acute retention was present. A suprapubic puncture was made. Later an operation was undertaken for the relief of stricture. I was not sure that the condition was malignant, although it was unusually hard. The operation consisted of opening the bladder and passing a sound retrograde. At the tip of the sound in the perineum the urethra was divided. The mass was dissected free and the distal end of the urethra severed beyond the involved tissues. About 1.5 inches of urethra was resected. By passing a number 18 catheter from the meatus, an end-to-end anastomosis was made. Convalescence was rather slow, but after a reasonable time the catheter was removed. The small perineal fistula remained but soon closed. Regular dilatation has been continued. The patient is in good physical condition and there is no evidence of recurrence after 9 years." The histologic diagnosis was squamous cell carcinoma.

Lower's Case 2 "A man aged 40 had gonorrhea at 22. Eleven years before he had acute retention which was relieved by perineal incision followed by a stricture requiring frequent dilatations. Acute retention was present and I was unable to pass any instrument through the stricture. A suprapubic puncture was done. A very indurated area was found in the perineum. A diagnosis of malignancy was made. A resection was done as in the previous case and x-ray therapy given. A union at the point of anastomosis at the ends of the urethra was not very satisfactory and a tight stricture resulted. Internal urethrotomy was performed 2 years later and since then dilatation at regular intervals has been done. There is no evidence of recurrence after 8 years." Histologic diagnosis: papillary carcinoma.

Lower's Case 3 "A man, aged 61 years, had gonorrhea at the age of 25. He was admitted with difficulty of urination. "An extensive induration was present in the perineum extending along the entire urethra. The inguinal glands on both sides were involved. Biopsy of the gland showed malignancy. Nothing short of an extensive block dissection seemed worth while. The penis, testes, and inguinal glands on both sides were removed and the urethra transplanted into the perineum. Bilateral hernias were present which were successfully corrected after the testes and inguinal glands were removed. It is now 3½ years later and there is no evidence of recurrence."

As shown by the literature, the operative results have been far from satisfactory. Of the 72 cases collected by Watson 79 per cent of the patients were dead within 6 months. Diehl puts the mortality rate at 80 per cent. Kreutzmann and Colloff in January, 1938, stated that they found



Fig 9 Photograph taken 7 months after operation showing great shortening of penis. BUI 26189

143 cases of carcinoma of the male urethra in the literature. For clinical purposes they listed the growths into "two main groups, depending on their location: (1) those occurring in the anterior or penile portion of the urethra, and (2) those found in the bulbomembranous or posterior portion. Anatomically, the bulbous portion is not a part of the posterior urethra, but for a study of their results, this arbitrary division is a rational one. In 60 of the 143 cases the carcinoma occurred in the anterior portion of the urethra. Seventy-eight patients had carcinoma of the posterior portion of the urethra. The growth was found most often in the bulbous or membranous part and occasionally in the prostatic part." The different forms of treatment described are "suprapubic cystostomy, internal or external urethrotomy or both, incision and drainage of the perineum, resection of the urethra and the growth, fulguration and application of radium, excision of the inguinal or the deep femoral glands, total emasculatation, passage of sounds and the use of an indwelling catheter. In this series of 78 patients with cancer of posterior regions only 11 (14.3 per cent) recovered, while 58 (74 per cent) died. In 9 (11 per cent) there was no mention of the end-result. The operation which gave the greatest number of cures was resection of the urethra with the included growth. This was performed in 5 [cases of Lower, Sokolov, Scholl and Braasch, and Oberlander]. In 1 of the 5 the inguinal glands were removed. In a second the penis was amputated and in a third radium was applied after operation. In contrast to the gratifying end-results obtained in the treatment of the growths involving the anterior portion of the urethra, carcinoma of the posterior portion possesses a gloomy picture."

#### RÉSUMÉ

A thorough study of carcinoma of the male urethra is to be found in recent literature. Our

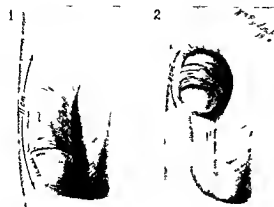


Fig. 8 Comparative views of penis before and after operation. Only glans and small portion of shaft were visible after operation. BUI 26189

cited by Imbert metastasis to the testis and in another to the bladder were present. In several reports in the literature in which cases of epithelioma of the pendulous urethra are cited, metastasis to the inguinal glands were found, and most authors are agreed that if amputation of the penis is done, removal of the inguinal nodes, preferably a block dissection along with the penis should be carried out. Lazarus stresses the importance of employing the technique of block dissection devised by Young for carcinoma of the penis and reports a case in which he employed this method.

#### OPERATIVE TREATMENT

Kretschmer expressed the generally accepted surgical opinion in 1923 as follows: "Just as soon as the diagnosis has been made nothing short of a radical operation should be employed, viz. amputation of the penis with transplantation of the urethra and complete extirpation of the inguinal glands." This opinion has been concurred in by various writers since that date. Some of the early authors advised complete emasculation, but recent writers have agreed that such mutilation is not helpful or necessary. Huggins and Curtis (1929) stated that for lesions of the anterior third of the urethra simple amputation should suffice, but that for urethral carcinoma between this point and the membranous urethra more extensive removal with perineal implantation of the urethra was indicated and that for cavernous lesions the entire penis with crura and urethra down to the membranous urethra should be excised. They reported a case in which this very extensive and mutilating procedure was carried out. In the older literature cases are reported in which excision of

the carcinomatous area through the perineum with cauterization of the wound was carried out.

A detailed study of cases of squamous carcinoma of the bulbous portion of the urethra was made by Marcus Beck in 1892. All the cases were inadequately treated except possibly that of Mikulicz, which was as follows:

In 1883 Mikulicz operated upon a patient with carcinoma of the bulbous urethra. There was a fistula present which was laid open, thus exposing a cavity the size of a hen's egg. When the superficial granulations were scraped away, a tissue was exposed resembling squamous carcinoma of the lip. The whole penis with the crura was removed, but recurrence took place in 4 months. Microscopic examination proved the growth to be a squamous carcinoma.

Oberlaender (1893) reported the case of a man aged 76 years, who had been treated for 4 years for a stricture of the urethra. It was discovered by endoscopic examination to be carcinoma. The tumor was in the region of the bulb, the size of a chestnut and somewhat lobulated. It was excised with the urethra 1.5 to 2 centimeters above and beneath the tumor. The ends were closed together with catgut sutures. Healing followed by primary intention in 3 weeks. The extirpated inguinal glands were negative. In 7 months the patient returned with a local recurrence which was easily palpable and visible endoscopically. Examination of the specimen showed around the lumen of the urethra a half circular tumor 4.5 centimeters long and 2.3 centimeters thick; microscopy showed flat epithelial cells. (Comment by Hilly: It is evident from the description that the corpora cavernosa were not removed.)

In 1922 Scholl and Braasch reported a case of a man with a hard nodular mass 2 centimeters in diameter in the perineum at the penoscrotal angle associated with a tight stricture of the urethra. At operation a growth 4 centimeters long was found at the junction of the membranous (bulbous?) and anterior portions of the urethra. The involved area was completely excised. Later complete emasculation of the penis and testicles with dissection of the inguinal glands was advised but refused by the patient. The specimen showed an irregular firm tumor about 3 centimeters in diameter—a squamous cell epithelioma. Six weeks later the urethra was reconstructed from a section of the internal saphenous vein. Two months later the area had completely healed save for a persistent perineal sinus. Radium (350 mgh) was applied to the urethra in the region of the scar through the perineal sinus. The patient was alive at the end of 5 years.

# FRACTURES OF THE NECK OF THE FEMUR

## Open Operation and Pathologic Observations. A New Incision and a New Director For The Use of a Simplified Flange

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**E**VEN before the days of Delbet, it is probable that men were attempting to apply some form of internal fixation for fractures of the neck of the femur to facilitate union and to shorten the disability.

However, our present concept of the operative treatment of this most difficult fracture has, with few alterations, been handed down from Delbet. He used bone grafts, nails, screws, and whole grafts of the fibula. Since then, many men, time and again, have advocated the use of these methods, only to have them fail to produce good results, apparently because of the failure of the proximal fragment to live and produce new bone.

In relation to the origin of directors for forcing bone or some other foreign material into the femur, we are also indebted to Pierre Delbet for having devised the first mechanical apparatus to aid the insertion of any material for internal fixation. It was first described in 1911 and was called the *canon de Delbet*.

Charbonnier also made a rather simple appliance, using the spine of the ilium and the symphysis pubis as the fixed points and then, by the use of a movable perpendicular third part, marking the center of the head so that a drill hole could be guided by this marker. Charbonnier described this apparatus first in 1923 and then again in 1932.

Hustin and Leemans, in 1933, used a rather crude guide for boring a hole into the head, but it was not an instrument of accuracy in any sense of the word. Sterling Bunnell, of San Francisco, also devised a director of almost mathematical perfection and published a description of it in the same year. In 1934, Brocq and Dulot, and Denis described ingenious devices for pegging the neck of the femur which required only a small lateral incision, just large enough to permit a drill, and a small anterior incision over the neck of the femur, which was used to direct it. None of these devices required an extensive arthrotomy.

In 1928, Smith-Petersen devised a three-flanged nail with a head. He made an extensive open

From the Fracture Ward, Cook County Hospital

arthrotomy and, after alining the fragments of the fractured neck, inserted the three-flanged nail. This method has without question given excellent results and many men have verified the results obtained and published by Dr. Smith-Petersen. However, the difficulty in this operation is that the nail does not always travel in the desired course, in the hands of some operators it has been almost impossible to make the nail take the desired course. It is because of the excessive cost of the Smith-Petersen nail and the difficulty of always directing it correctly that we have been stimulated in our research in an effort to produce a simpler nail or flange which could be used with a director. In our opinion, however, Smith-Petersen's original idea that an arthrotomy is essential to the accurate apposition of the fragments in a case of fractured neck of the femur is fully justified. We find that while certain types can be reduced into almost perfect position by closed manipulation, in other types either a spicule from the proximal fragment or a spicule from the distal fragment has pierced the capsule in such a manner that re-apposition of the fragments into proper position by closed manipulation is utterly impossible. We have been able also to demonstrate, in a certain number of cases, a very definite interposition of the periosteum and synovia detached from either the proximal or distal fragments and dislocated between these fragments in such a manner that it could, without question, prevent union if it were not removed at open operation.

In the spring of 1934, Dr. Ottolenghi, of Buenos Aires, demonstrated a guide or director which he and Dr. José Valls had constructed. This device appealed to our imagination, and upon its basis of construction Dr. Scuderi proceeded to modify the apparatus as here described.

The flanges are made of stainless steel. They embody all of the advantages of the Smith-Petersen nail, from which they have been copied, and, in addition, their utter simplicity of shape and ease of manufacture reduce the cost of manufacture to a minimum (Figs. 1 and 2).

paper is intended primarily to discuss the operative treatment of carcinoma of the bulbous urethra, but we have referred briefly to carcinoma of the penile and also of the membranous urethra. The accepted operative procedures, as outlined by various authors for carcinoma of different parts of the urethra have been given.

Cases of carcinoma of the bulbous urethra that have been subjected to radical operation have been quoted in detail.

From these studies it seems evident that the technique employed in the case which forms the basis of this report is the only one in which a large growth involving the three cavernous bodies in the bulbous urethra has been radically excised with all three cavernous bodies but without removal of the penis. This was accomplished by division of the urethra and three corpora anteriorly at the penoscrotal juncture and posteriorly close to the membranous urethra. The great defect produced by this extensive removal of the urethra and three corpora has for the first time been closed by pulling back (telescoping) the penis and anastomosing it to the stump of the bulbous urethra near the triangular ligament.

It seems that this technical procedure has not previously been carried out. The ease with which it can be accomplished and the elimination of the great urethral defect by means of backward displacement of the shaft of the penis and anastomosis of the penile urethra to the bulbomembranous urethra are remarkable factors.

This operation might also be applied satisfactorily to urethral carcinoma of the scrotal and upper penile portions, and thus penneal transplantation of the stump of the urethra and loss of the penis avoided. Total emasculation is thus avoided by this new operation.

#### CONCLUSIONS

Study of the 145 cases of carcinoma of the male urethra shows that the larger proportion are situated back of the penoscrotal juncture.

Early radical operation is recognized as of prime importance when the lower penile urethra is alone involved. Amputation in continuity with block dissection of inguinal glands is the accepted procedure.

For carcinoma farther up the urethra (high penile and bulbous), complete removal of the penis and bulbous urethra, in part, with transplantation of the posterior portion into the perineum has been the accepted procedure.

For these cases a new method is proposed by means of which the penis is spared and the great defect, left after removal of the bulbous and scrotal portions of the urethra along with the three cavernous bodies, is done away with by drawing the penis back into the perineum and suturing it to the bulbomembranous urethra and triangular ligament. This operation allows more radical excision of the perineal structures involved and avoids amputation of the penis, or plastics which lead to stricture. It is both radical and conservative.

I wish to thank Dr. Wyland F. Leadbetter, resident urologist, for much assistance and Mr. William F. Dicusch for the beautiful drawings which have so completely illustrated our operative technique.

#### BIBLIOGRAPHY

1. BECK: *Internat. Clin. ed. series* 1892 256
2. HARRACH: *J. Urol.* 1937 38 471
3. MORGAN and CLATIS: *Surg., Gynec. & Obst.* 1929 48 544
4. KERN: *J. Urol.* 1931 27 559
5. KREUTNER: *Arch. Surg.* 1923 6 830
6. KREUTNER and COLLOFF: *J. Am. M. Ass.* 1931 110 184
7. LOWER: *Tr. Am. Ass. Genito-Urin. Surg.* 1931 24 249
8. NITZLICH: Quoted by Beck: *Internat. Clin. ed. series* 1892 2 256
9. OVERLAEGER: *Internat. Centralbl. f. d. Physiol. u. Path. d. Harn- u. Sexorg.* 1893 4 244
10. SCHOLL and HARRACH: *Ann. Surg.* 1927 76 246
11. SKOLOV: Quoted by Goldstein: *Ann. Surg.* 1937 105 213
12. WATSON: *J. Urol.* 1929 21 217
13. *UROLOGICAL PRACTICE OF UROLOGY*, Philadelphia and London W. B. Saunders Co. 1926

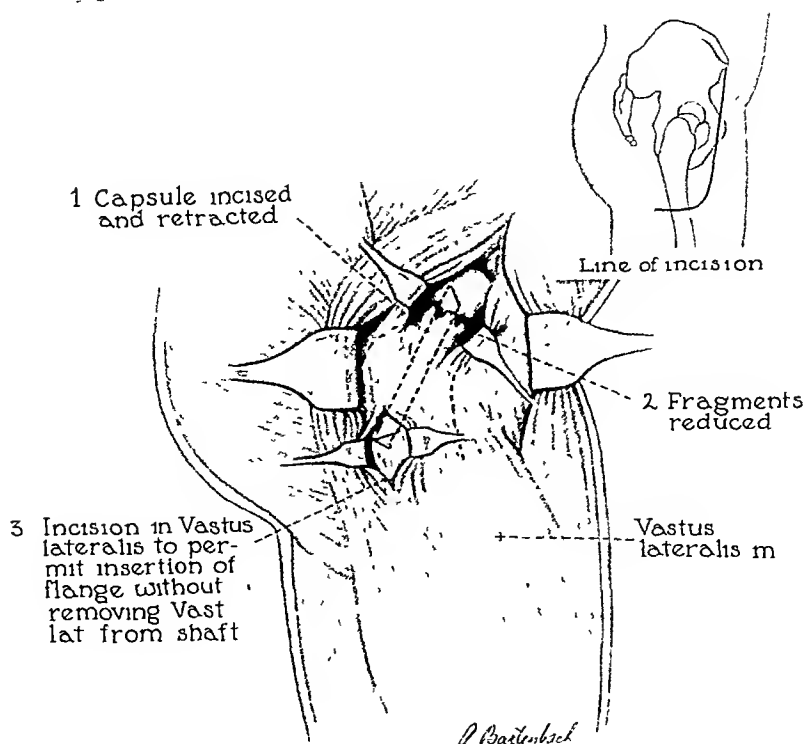


Fig 8 This drawing shows the line of dissection in an approach to the hip. Although several artistic liberties have been taken in order to portray the details which we desired, in the main the essentials of the exposure are well presented

so that it must follow the course governed by the directing bar (Fig 3)

On the front end of the directing block is a sharp prong which is driven into the shaft of the femur just below the trochanteric bulge, so that the flange will travel into the head in a valgus position

When both the prong of the directing bar and the directing block have been firmly fixed, the thumb screw on the top of the block is tightened so that no slipping can occur. The number of the flange to be used in any specific case is indicated by reading the number on the top of the directing bar. If the specific length of flange indicated is used, one is assured that the flange will be long enough to reach the head of the femur and yet not perforate the acetabulum.

Occasionally the cortex of the femur is very hard and will turn the edge of the flange. A starting chisel (Fig 4) may be used in such cases to make the original cut in the cortex, the flange will then go in with greater ease and accuracy.

In either the adolescent or an old woman in whom the femoral neck is very thin, a flange of greater width is apt to cause fragmentation of the femur, therefore a narrower flange is recommended. The director is made to accommodate the different flanges, when the narrower flange is used a small metal adaptor is slipped into the directing block to hold it firmly.

The flange is inserted into the directing block and a punch with slotted handle called the inserter (Fig 5), is fitted over the end of the flange. With a mallet the flange is driven in. The inserter serves three purposes: (1) It prevents the formation of a burr on the hammered end of the flange. (2) After the flange is completely driven in, by means of its shoulder the inserter prevents the holes in the head end from being buried. (3) A few mallet blows on the inserter impacts the fracture surfaces together.

When the flange has been driven about two-thirds of the way in, it no longer can change its course. The director is removed so that the flange

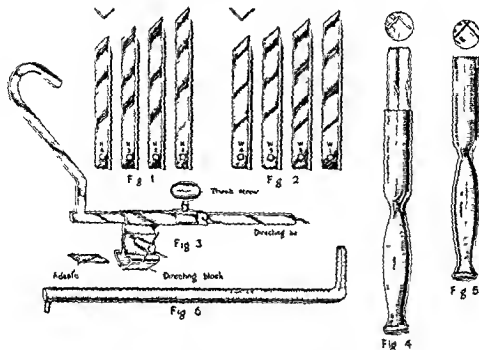


Fig 1 Four juvenile size flanges  $w$  of varying lengths  $3\frac{1}{2}$   $3\frac{1}{4}$   $4$   $4\frac{1}{4}$   $4\frac{1}{2}$  inches in width. The flanges are made of stainless steel.

Fig 2 Four adult size flanges  $w$  of varying length  $3\frac{1}{4}$   $3\frac{1}{2}$   $4$   $4\frac{1}{4}$   $4\frac{1}{2}$  inches in width made of stainless steel.

The flanges are made in four lengths  $3\frac{1}{2}$ ,  $3\frac{3}{4}$ ,  $4$  and  $4\frac{1}{4}$  inches, and in two widths  $\frac{3}{8}$  inch (for the adolescent and the aged women with very narrow femoral necks) and  $\frac{1}{2}$  inch (for the average adult with a normally thick femoral neck).

This director was devised with the hope of facilitating the accurate pegging of the fragments—a difficult procedure even when the hip joint has been widely exposed. The director is quite different from the original shown by Drs Valls and Ottolenghi.

Fig 3 Assembled director ready for use with either width flange.

Fig 4 Starting chisel.

Fig 5 Insertor.

Fig 6 Extractor.

The directing bar has a long sharp prong which is inserted into the anterior lip of the acetabulum, so as to bisect the head. On its top surface are the markings 1 2 3 4 which indicate the length of nail necessary accurately to peg the head fragment. The directing bar has a handle to stabilize it during its use and to facilitate its handling.

The directing block is manipulated in much the same manner as are the sights of a rifle except that it is movable instead of fixed to the barrel. The directing block keeps the flange in a groove.

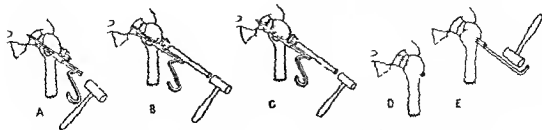


Fig 7 Set of schematic drawings showing the various steps in the use of the director and the accessories. A. Instrument in place ready for use. B. Cutting cortex with

the starting chisel. C. Driving in flange with the insertor. D. Dotted lines indicate flange in place. E. Extractor in use.

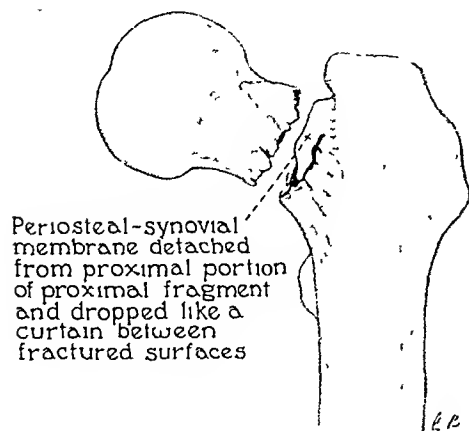


Fig 11 Reveals curtain between fragments

limb is fixed in extension in a Thomas splint. If bed sores or other conditions prevent the patient's lying on his back continuously, it is possible to dispense with the traction and to allow the patient to be free in bed and be turned to the opposite side or down on the face. The patient is usually returned to the ward, where about 7 to 10 pounds of weight with the limb in extension is used for a period of 10 to 14 days. After this period only thigh extension is used and by means of a Pearson attachment the knee function is resumed. At the end of 3 to 4 weeks all extension is discontinued. Patient then lies flat in bed, and 7 to 10 days later he may be up and around in a walking caliper, which can be removed at night.

When bone growth occurs early, which can be demonstrated with the x-ray, walking on the limb operated upon is permitted at the end of 6 months. But, if no bone growth is evident, longer periods with the caliper are necessary. Usually at the end of 7 to 9 months a bursitis develops over the end of the flange, causing considerable discomfort to the patient. If there is adequate bony union, the flange should be removed. This can be easily done under local anesthesia. In some instances, the flange works itself into the subcutaneous tissues, this necessitates removal.

Our first and most startling observation is that, irrespective of the apparent transverse line of fracture of the neck of the femur according to the x-ray, it is not uncommon to find at the time of operation that there is more or less obliquity. This obliquity is most commonly characterized by a long anterior spicule on the proximal fragment. However, this particular type of obliquity varies in every direction, from above down, from below up, and from before backward. This fact has been

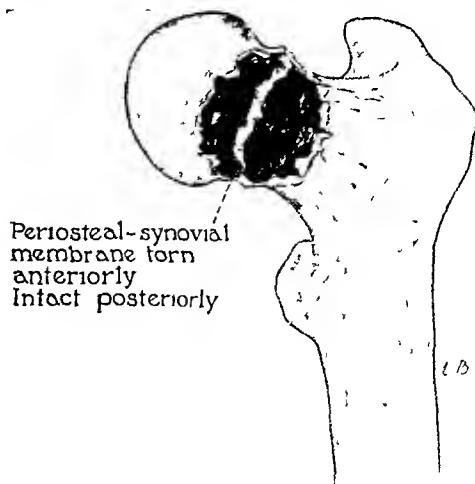


Fig 12 Fracture with intact, periosteosynovial membrane

emphasized by Dr. Paul B. Magnuson. We have observed other common variations, in which there have been spicules of bone on these fragments, varying in length from  $\frac{1}{2}$  to  $\frac{3}{4}$  inch and yet the fragments appeared from the x-ray study to be perfectly transverse.

Another observation which must be carefully mentioned is that the long fragments, particularly when they are on the anterior surface of the proximal fragment, can and do pierce the Y ligament of Bigelow at its middle or at its lower attachment to the femur in such a manner that it is almost impossible to reduce it by any type of manipulation. We have not as yet been able to demonstrate this type of perforation in the posterior portion of the capsule.

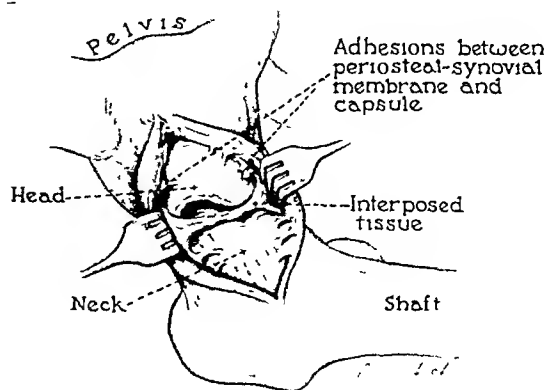
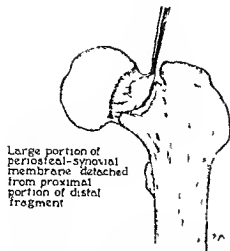


Fig 13 Typical interposition, as seen in old cases





Large portion of periosteal-synovial membrane detached from proximal portion of distal fragment

Fig 9 Detachment of periosteal synovial membrane from the proximal portion of the distal fragment

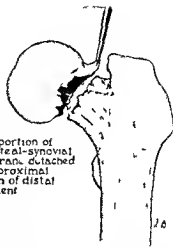
can be driven in the remainder of the way. A thumb release is on the right hand side of the directing block to facilitate its removal if the flange fits too snugly into the block.

Should the flange accidentally be driven in too rectly, and one desires to remove it, it can be removed by the use of the simple extractor (Fig 6). The small prong is inserted through the hole in the flange, and it is hammered out (Fig 7E).

#### SURGICAL APPROACH

The incision (Fig 8) we have found to be the best in these operations has been developed in the anatomical laboratory by Dr Callahan. The skin incision is made from the anterior superior spine downward toward the knee for a distance of about 8 inches and it then dips posteriorly with a hockey stick curve. The line of cleavage between the sartorius and the anterior border of the tensor fasciæ femoris is then found and this border of the tensor fasciæ femoris is followed until its lower end reaches its fascial attachment. This fascia is then cut transversely and the gluteus medius and tensor fasciæ femoris are retracted posteriorly while the rectus femoris is retracted medially. At this point, the operator can see the branches of the lateral circumflex femoral vessels which can be clamped and tied before they are cut. As a rule there are two or three other small branches which can also be seen and clamped before they are cut. In this manner, an almost bloodless approach to the neck of the femur can be made.

The lateral portion of the rectus femoris and the belly of the iliacus are retracted medially



Small portion of periosteal-synovial membrane detached from proximal portion of distal fragment

Fig 10 Fracture similar to that in Figure 9 with small portion detached

thus exposing the capsule covering the hip joint. The capsule is then incised in the course of its fibers from the acetabular rim down to its insertion into the intertrochanteric region of the femur. Later the capsule may be incised as is necessary, but this method preserves the landmarks. The capsule is then detached from its anterior femoral insertion in such a manner that the fragments are exposed and brought into full view.

If the fragments have not been brought into contact by the manipulations previous to the open operation, at this point they are exactly opposed. In this way, the greatest possible area of bone surface is brought into contact.

When the fragments are in exact apposition, a longitudinal incision is made in the vastus lateralis in the direction of the fibers just below the greater trochanter and the underlying femur is exposed. The long, prong of the directing shaft is now inserted into the edge of the acetabulum (Fig 7A).

The directing block is then fixed in the shaft of the femur just at or below the bulge of the trochanter major by placing the prong of the directing block through the opening made in the vastus lateralis. This is locked to the directing shaft by turning the thumb screw on its top. The flange is now inserted through the directing block and driven home with the inserter (Fig 7B).

The capsule is replaced and loosely sutured. The wound is closed with interrupted catgut sutures and Michel clips or silk sutures are used for the skin. Buck's extension is applied and the



A

B

C

Fig 15 A, J L, aged 60 years Injured May 5, 1935 Roentgenogram shows the position of the fracture after the patient had been in traction a few days Please note that this is a long oblique fracture with a sharp spicule on both the proximal and distal fragments B, Patient was operated upon June 19, 1935 This figure shows the position immediately following the operation with the flange inserted Note the complete change in contour of neck and

the impossibility of recognizing the sharp fragments, because they had been accurately reduced The flange was a little too long for this neck C, Walking was permitted October 5, 1935 This film was taken January 8, 1936, shortly after the removal of the flange One can see the groove through the neck of the femur where the flange had formerly been Close examination shows a complete resorption of the trabeculae through the neck

It is not as yet possible to discuss the final outcome of the cases in which this aseptic necrosis has been definitely proved to be present by microscopic examination This will be discussed in a later communication

#### RESULTS

Up to January, 1938, we have operated upon 105 patients with fracture of the neck of the femur Ninety of these were openly reduced within the first 2 weeks Fifteen operations were performed from 5 weeks to 6 months following injury The age of the patients varied from 14 to 82 years, this includes both males and females Shock did not occur in any of our patients following open arthrotomy We have had 1 death caused by overlooking a point of infection on the leg, below the hip joint operated upon In this patient operation was followed by infection and exitus

There were 3 contracted hips in patients in whom the capsule had been left open Although these contractions occurred late—1 a convalescing patient with pernicious anemia and the 2 others individuals who developed senile dementia—the possibility that an excessive development of scar tissue in the open capsule might be a cause should be considered

In 2 cases the femoral head was resorbed following the operation The flange worked loose and was extruded one-half its length outside of the shaft The femoral neck in one woman was partially absorbed, but the femoral head was viable, and she has had a painless useful limb, with 1 inch of shortening We believe these 3 cases must be classed, 2 as failures and 1 as fair, and that they are the result of inaccurate apposition of the fragments or unobserved interposition

This is a total of 7 unsuccessful results: 1 failure, 1 death, 2 non-unions, and 3 hip contractures It seems to be true that the early surgical treatment with correct replacement of the fragments has a very favorable effect upon the viability of the femoral head, as up to the present time over 90 per cent of all these early operations have been successful (Figs 14 and 15). We are convinced, although without microscopic proof, that many so called cases of aseptic necrosis of the head have undergone a rapid creeping substitution, with an early exact approximation of the fragments.

#### SUMMARY AND CONCLUSIONS

1 We have operated upon 105 patients with no shock and only 1 operative death The ages of the patients varied from 14 to 82 years, and even though the mortality rate has been low, we have

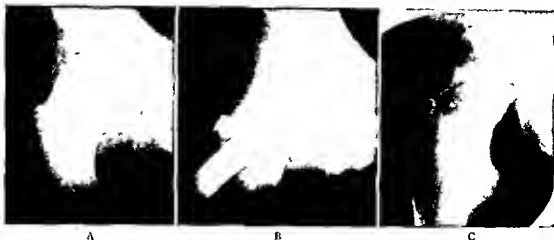


Fig 14 A B C aged 27 years Injured August 24 1935 Roentgenogram shows a transverse subcapital fracture of the neck of the femur apparently in good position The head appears viable Operation was performed September 5 1935 B Taken September 8 1935 3 days after operation Note an apparent filling defect of the

inferior margin of the neck This was caused by a loss of bone tissue Patient was discharged from the hospital on October 30 1935 C Taken on June 4 1936 shows the flange removed and a complete bony union of the fracture line There has been a filling in of the bone defect as seen in Figure 14 B Valgus position has been maintained

We have also noticed sheets of the periosteum and synovia detached from the proximal portion of the distal fragment (Fig 9) dropped as a curtain down between the fractured ends of the femoral neck This same phenomenon has been observed when the periosteal synovial membrane has been detached from the osteocartilaginous line of the proximal fragment and also fallen as a curtain between the fragments (Fig 10) We also have had 2 cases in which the osteoperiosteal membrane has been completely detached from both fragments and dropped between the fractured surfaces These pieces of periosteal synovial membrane vary in size from a ribbon shaped piece about  $\frac{1}{4}$  inch wide to a curtain  $1\frac{1}{4}$  inches wide and 1 inch long (Fig 11)

Incomplete fractures of the neck of the femur are not uncommon We have had four in patients over 60 years of age in whom there was a fracture of the anterior surface of the femoral neck distinctly subcapital in which there was not a complete separation of the periosteal synovial membrane on the posterior surface of the femoral neck (Fig 12) In other words the posterior portions of the fragments had been held in contact by the periosteal synovial membrane

In 1 patient upon whom we operated late we have every reason to believe that a large curtain had fallen in between the fragments and caused a non union (Fig 13)

Regarding the Leadbetter method of reduction of a fractured neck of the femur, we are convinced

that when the capsule has been perforated by the sharp spicules either from the proximal or distal fragment it is not possible to bring about reduction by any closed method In fact, in a series of about 35 cases, the reduction in nearly one half of them was not perfect by any manner of means as we found when the joints were opened by the Callahan incision which revealed the entire anterior portion of the joint

We have attempted to prove the viability of the head by taking a scoop of the cancellous bone and then having multiple microscopic sections made from this specimen In some of these there has been an aseptic necrosis of both the head and the proximal portion of the one distal fragment We are not as yet prepared to state that this aseptic necrosis is not the same type of necrosis which is so common in the ends of all fractured bones In some sections removed from apparently aseptic necrotic heads, the heads have lived and produced bone

The amount of blood and blood clots which are found in the joint that is opened in 1 to 2 weeks is an excellent indication of the viability of the proximal fragment In some joints there is only a small amount of bloody serum with few if any small clots The microscopic examinations of bone removed from both proximal and distal fragments in these cases have shown a definite aseptic necrosis or as we prefer to call it dormant bone to be present both in the proximal and distal fragments

# TECHNIQUE OF ANASTOMOSIS USING THE STONE CLAMP

JAMES C OWINGS, M D , and HARVEY B STONE, M D , F.A.C.S , Baltimore, Maryland

SINCE the recent publication of the short preliminary article (2) showing the details of construction of a new clamp for performing aseptic end-to-end anastomoses, we have modified the technique considerably and have also used this clamp for lateral anastomoses, end-to-side anastomoses, and for operations involving resection of the stomach. It also works very nicely for the excision of Meckel's diverticula. We feel that we have now had sufficient experience with these various procedures both clinically and experimentally to make a detailed description of the technique of some lasting value. It would seem essential that these details be put before the public as soon as possible because of the spreading use of the new instrument. All of the changes which we have made have been to render the operations less difficult and make them safer. We feel that it is absolutely essential for anybody using this clamp to understand and follow the details of technique as exactly as possible if uniformly successful results are to be expected. For the purpose of exhibiting these techniques in detail we have had prepared a fairly large series of drawings which are published herewith.

Figure 1 shows the mesentery of the small bowel divided down to the marginal vessel which is shown isolated and tied but not yet divided. The actual isolation and tying of this vessel, thereby giving free exposure to the muscle of the bowel wall at the site of the contemplated resection, is

From the Surgical Hunterian Laboratory of the Johns Hopkins Medical School

quite essential, not only from the viewpoint of giving adequate exposure for the laying of the sutures at a later step, but also for the prevention of damage to the blood supply at the site of the future anastomosis by blind clamping or hematoma formation, either of which at any stage of the operation might so embarrass the blood supply as to make the suture line unsafe. When this vessel is isolated and tied ahead of time, if any such accident should occur, the site of the resection can be readily changed without any loss of time. In choosing the site for the resection it is well if possible to pick a point very close to one of the larger mesenteric vessels so that adequate blood supply is assured. The bowel is crushed with an ordinary Kocher clamp before the application of the resection clamps. The resection clamp is oiled, before being applied, to prevent sticking. A Kocher clamp is placed on each end of the segment to be resected as close to the resection clamp as possible, and the bowel is cut flush against the resection clamp with the actual cautery. If there is disproportion, the clamp on the segment with the smaller lumen can be applied obliquely toward the antimesenteric border in order to increase the size of its lumen.

Figure 2 shows the bowel divided and the segment which was to be resected removed, with the ends of the bowel being brought together for the anastomosis. It will be noted that instead of the clamps having been applied in a line parallel to the mesentery as is the common practice today, they are applied at right angles to it. So far as we

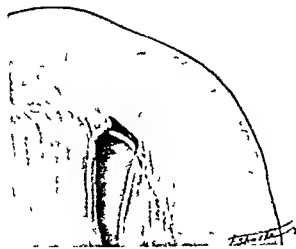


Fig 1

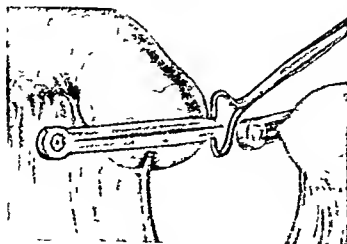


Fig 2

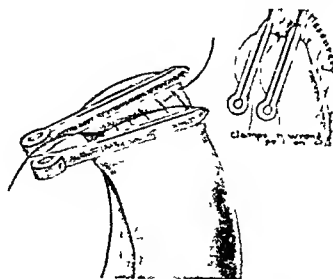


Fig 3

Fig 1 The mesentery is divided down to the marginal vessel which is shown tied but not divided

Fig 2 The diseased segment has been resected. The ends of bowel are being brought together for anastomosis, the resection clamp is applied at right angles to mesentery

Fig 3 The posterior layer of the continuous silk suture has been laid but has not been completely pulled down as yet. The inset, upper right corner, shows the resection clamps placed parallel with the mesentery which we consider to be the wrong position

no illusions as to the inability of aged patients to withstand the shock of any operation

2 The incision gives excellent exposure with a very small amount of bleeding

3 The director is of the greatest possible value in accurately approximating and holding the fragments in position, and we are sure that early careful approximation and fixation are of the utmost importance if we are to expect a good growth of bone

4 Convalescence is much more rapid and the patient is far more comfortable than he has been with any previous method in our hands in addition he has been saved thousands of bed hours in the hospital

5 This method has not been so successful in fractures of long duration, in spite of most accurate approximation in some cases there has not been an adequate amount of bone growth to keep the fragments firmly together Slipping and loosening in old fractures have occurred just as with any other method of fixation

6 Results have been better in those patients in whom we have had a persistent valgus position

7 The flange is more easily and accurately applied than a screw, and we believe holds more firmly

8 In 90 per cent of the fresh fractures bony union resulted

#### BIBLIOGRAPHY

- 1 BROcq P and DULOT Presse méd 42
- 2 HUNNELL S Surg Gynec & Obst 1933 57 685  
688
- 3 CHARBONNIER A Rev méd de la Suisse Rom 1932  
52 683-691 Lyon chir 1921
- 4 DELBET PIERRE Quoted from Brocq and Dulot also  
Leveuf
- 5 DENIS R Presse méd 1934 43 1934
- 6 HUSTIN A and LEEEMANS Bull et mém Soc nat de  
chir 1933 59 740-744 Scalpel 1933 86 1591-1595
- 7 LEVEUF JACQUES Fractures of the Neck of the Femur  
Monograph 1927
- 8 SMITH LETERSEN M CAVE F and VANCORDER C  
Arch Surg, 1931 23 715-759

# TECHNIQUE OF ANASTOMOSIS USING THE STONE CLAMP

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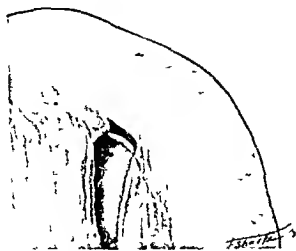


Fig 1

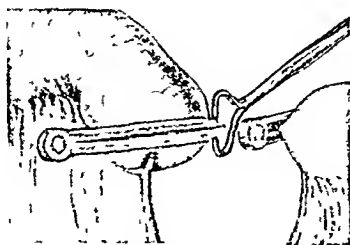


Fig 2

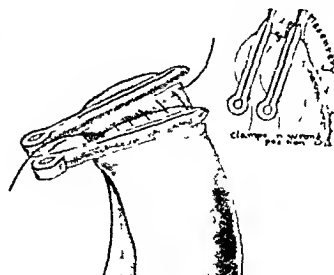


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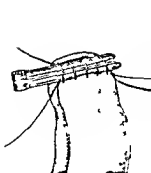


Fig 4

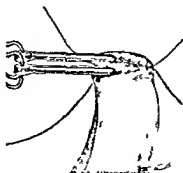


Fig 5



Fig 6



Fig 7

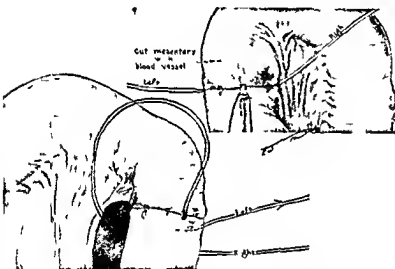


Fig 8

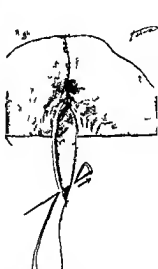


Fig 9



Fig 10



Fig 11

Fig 4 The anterior layer of No. 0 chromic catgut is shown laid. The handles of the clamp have been omitted for the sake of clarity.

Fig 5 The clamps have been released and are being withdrawn together as the anterior layer is pulled tight to

complete the first layer of the anastomosis. Note the application of the handles to the opposite end of the blades to facilitate this maneuver.

Figs 6 and 7 The beginning of the anterior layer of mattress sutures is shown. The first stitch is used to invert the knot where the catgut has been tied to the silk and is left long for traction as indicated in Figure 7.

Figs 8 and 9 The method for gaining exposure to the posterior surface of the bowel is shown. One of the sutures which has been left long is passed through the rent in the mesentery and by making gentle traction in opposite directions on both sutures the bowel is turned upside down as shown in Figure 9.

Fig 10 This inset merely shows an enlarged view to emphasize the importance of laying one mattress suture directly at the mesenteric border.

Fig 11 The anastomosis is shown completed and the rent in the mesentery is being closed. Note that the eye of the needle, instead of the tip, is used for sewing.

Fig 12 This figure shows the closure of the triangular space at the border of the mesentery on the opposite side from Figure 11.

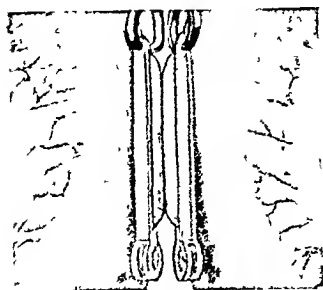


Fig 13

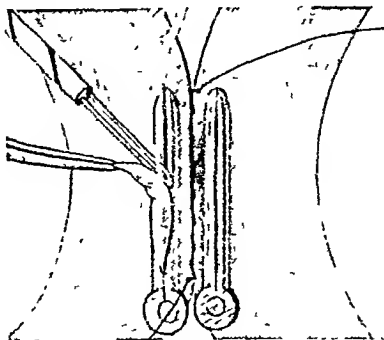


Fig 14

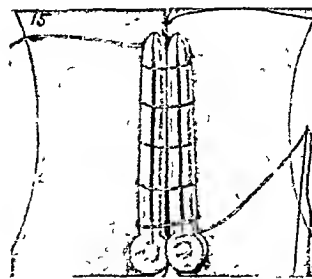


Fig 15

Figs 13, 14, and 15 These three drawings illustrate the method used to perform an aseptic lateral anastomosis. They are self explanatory. The procedure from this point is completed in the same manner as in the end-to-end anastomosis.

know this method of application is new, although it has probably been used many times and never reported. We think that it is a very important step in the technique of doing an end-to-end anastomosis because it gives so much better exposure to the mesenteric border, which is always the hardest point to handle because of the danger of leakage and possible damage to the blood supply. With the clamp placed in this manner the bowel wall can be exposed down to the muscle and the suture lines laid to the desired depth without danger. If one is using the clamp for a Parker-Kerr type of inversion, this method of application is also of great value because it places the mesentery in the center of the clamp where it is easy to invert instead of at the tip where it is next to impossible to invert. This technique is being taught the Hopkins students, but we have never seen it pictured or described in any of the current textbooks or systems of surgery. One of us (Owings) started to teach this method in 1927.

Figure 3 shows the posterior line of continuous silk laid but not yet pulled down tight. The handle of the clamp has been omitted for the sake of clarity. The inset in the corner is merely made to emphasize the common way of applying the clamps which we consider to be the wrong way. It shows the clamps placed parallel with the mesentery, the mesentery being held in the tip of the clamp.

Figure 4 shows the posterior layer of silk pulled down and tied and the anterior layer of No. 0 or No. 00 chromic catgut laid over both clamps but not yet pulled down. We are using chromic catgut in this anterior layer instead of silk for two reasons: first, it is stronger, and, second, it slides more smoothly. Silk has a tendency to grab and because of this to pull down tight at both ends leaving the middle loose and improperly inverted. Chromic catgut overcomes this difficulty.

In Figure 5 the clamps have been released from the crushed edge of the bowel and are being withdrawn together. The handles of the clamps have been removed from the tip and placed on the hinge to facilitate this procedure. The anterior suture of catgut is being pulled down as the clamps are withdrawn to complete first layer of anastomosis.

In Figure 6 the posterior layer of silk has been tied to the anterior layer of catgut, but was first tied on itself to prevent any possibility of purse-string action. The anterior row of mattress sutures has been started. This layer is always started at the corner so as to invert the knot and is left long to be used as a traction suture. The mattress sutures must be narrow in order not to strangulate too much tissue.

Figure 7 shows the anterior row of mattress sutures completed with the two corner ones left long. The average anterior layer would contain 6 or 7 sutures, but only 4 are shown here for the sake of clarity.

Figure 8 shows the method used to get exposure to the mesenteric border. The end of one of the

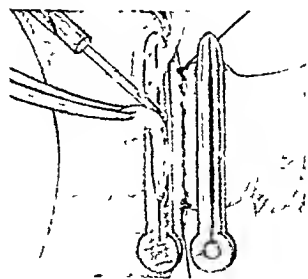


Fig 16 This drawing illustrates our method of performing an end-to-side anastomosis aseptically. From this point, the operation is done in the same manner as it is done in the end-to-end procedure.



two mattress sutures which have been left long is carried through the rent in the mesentery and by applying gentle traction the bowel is turned up side down as shown in Figure 9. Figure 9 also shows the posterior line of mattress sutures partially laid. Two more would ordinarily be laid where the posterior layer of silk is still showing. We always make a point to put one suture right at the mesenteric border to insure good coaptation at this point as better illustrated in Figure 10 where the suture has not yet been tied. Figure 11 shows the bowel turned back into normal position with the external layer of mattress sutures completed. The mesentery is treated in one of two manners. Usually it is closed by direct coaptation care being used to close the triangular space in the exact position it was before it was divided. Sometimes the mesentery is overlapped as suggested by the Mayos (1). The rent in the mesentery is closed by a very carefully placed continuous suture of silk shown beginning in Figure 11. The closure of the small triangular mesenteric space on the opposite side is illustrated by Figure 12. It will be noted that the eye instead of the point of the needle is used for sewing to prevent damage to the mesenteric vessels.

Figures 13, 14, and 15 show the technique of performing a lateral anastomosis aseptically with the same instrument. Figure 13 shows the bowel brought together with the portion to be resected bulging through the blades of the clamp. In Figure 14 the posterior layer of silk has been laid and tied and the bowel wall has been cut away with cautery on one side and is shown in the process of excision on the opposite side. Figure 15 shows the method of laying the anterior row over both clamps. From this point on the anastomosis is completed in exactly the same manner as shown for the end-to-end anastomosis, the final layer in each instance being a row of mattress sutures. Access to the posterior wall can be gained in the same manner also. About the only situation in which this operation is not feasible is when one encounters a very narrow terminal ileum making resection of a portion of the bowel wall dangerous because of the consequent further narrowing of its lumen. In this case we still use the old open method of anastomosis.

Figure 16 shows the same method applied to an end-to-side anastomosis. The posterior layer of silk has been laid and tied and the segment of the bowel wall to be used for the lumen of the anastomosis is shown in the process of excision. From this point onward the operation is done in exactly the same manner as previously shown in the technique for end-to-end anastomosis.

We feel that this clamp has certain very definite advantages over the previous instruments used for this purpose. It has a very narrow blade which therefore crushes very little tissue and consequently produces a very narrow cuff, thereby obviating the liability of diaphragm formation which has been one of the dangers to all of the older methods. In spite of this narrow blade, its strength and longitudinal grooves, together with the fact that it crushes evenly throughout its length, prevents any possibility of its slipping off and thereby soiling the field of operation. The fact that the handles are adjustable to right angles and the blades very short allows the instrument to be used in deep positions such as low in the pelvis where it would be impossible to work with any other type of instrument. Because of this fact a good many patients have been saved from a complete abdominoperineal operation. It is so simple and easy to handle that it saves a great deal of time, which is particularly important in this type of operation. It makes it easy to do aseptic end-to-end, lateral and end-to-side anastomoses. We have used a somewhat larger model of the same clamp for stomach resections using the same closed aseptic technique. However we had one case of severe hemorrhage and therefore, are somewhat doubtful as to the wisdom of using the instrument for this operation since it is impossible properly to control the large vessels in the stomach wall when sewing more or less blindly. We have found it quite useful for the inversion of the duodenum, however, because it destroys so little tissue and is easy to work with down in this more or less inaccessible region. The Parker Kerr method of inversion is used and reinforced with a layer of mattress sutures.

#### REFERENCES

1. MAYO C. H. Ann Surg 1933 98 834-838
2. STONE H. B. Surg Gynec & Obst 1937 65 383-384

# THE MODERN TECHNIQUE OF SUBTOTAL THYROIDECTOMY

JOSEPH L. DE COURCY, M D, F.A.C.S., Cincinnati, Ohio

IT is my purpose here to gather together into a synthesis the complete ensemble of pre-operative, operative, and postoperative treatment that has raised thyroidectomy from the status of a terrifying surgical specter to that of a safe and almost bloodless procedure with a mortality of less than one-fourth of 1 per cent in the hands of experienced surgeons, and a procedure having to its credit the restoration to health and usefulness of many thousands of unhappy toxic goiter patients.

I should like to stress what seems to me the importance of encouraging a greater number of general surgeons in localities remote from special thyroid clinics fitting themselves to carry out the technique of this modern operation. It will always be true that large clinics specializing in the surgical treatment of goiter are indispensable in this age of terrific nervous wear and tear, and that these centers can furnish the best care to patients able to remain indefinitely in the neighborhood for observation and treatment until cure is complete (often a long, slow process). The fact remains, however, that a substantial number of patients have to travel a long distance to reach one of these goiter centers, and that, for economic reasons, they can remain under the observation of the clinic for but a limited time. Large numbers of these patients must, far too soon, return to their own community and to the care of a clinician who has not the specialized understanding and experience of these cases.

How little the word of a thyrotoxic patient is worth in response to follow-up letters from the clinic, has been emphasized by Miller. His answer will be no true index to his degree of recovery. Such a patient will say he feels fine, though his pulse may be running wild as he writes. All these patients require the frequent examination of one who understands thyroid behavior and can determine to what degree the operation has been a success. Was sufficient thyroid tissue removed? Was too much tissue removed? Is further operation necessary? Or is the patient now a hypothyroid? Does he require thyroid extract? To answer these and other similar questions the presence on the spot of the surgeon who did the

operation is highly desirable. It may even be the determining factor in the patient's complete recovery.

It is unfortunately true that the great mass of the medical profession has a very imperfect conception of the requirements of these patients. The importance of correct postoperative care is so great that, if the operation and its follow-up treatment can be in the hands of one and the same surgeon for months or years, the advantage to the patient is immeasurable. It is possible for any surgeon of wide general experience to establish a competent thyroidectomy technique and to carry it out with an absolute precision which eliminates the risk of unexpected complications. It is the surgeon of this class that I have in mind in presenting this paper.

## PRE-OPERATIVE PREPARATION

One should never be in a hurry about operating upon a thyrotoxic patient. The first prerequisite is rest of mind and body. In most of these cases the patient has been suffering for months or years with a sense of inability to bear the burdens that life presents. The mind has been in a state of worry, the body in a state of tension. The nerves and heart have reacted unfavorably.

If the case is one of only moderate hyperthyroidism, the patient may be allowed to sit up in a chair for a part of each day and even to take short walks about the hospital or its grounds. In more severe cases the patient is put to bed and kept there strictly for several weeks. In any case, the patient must be in the hands of cheerful and understanding physicians and nurses, who are equipped to maintain morale and to minimize the tendency to worry about domestic, financial, or other troubles. The patient's confidence must be gained and his fears with reference to the operation allayed. The hyperthyroid patient is always a hypersensitive individual and has a capacity for suffering that is absent from those who are built on a more phlegmatic pattern.

The diet must be carefully chosen to provide approximately 5000 calories per day. This high caloric diet must consist of materials easily digested and should contain a large amount of sugar to insure a good storage of liver glycogen. Candy

may be permitted *ad libitum*, unless there are diabetic complications. Meats are not prohibited, but must not be given in too large amounts. Fluids are given in large quantities, up to 3 to 4 liters a day. If edema appears due to the cardiac conditions, fluid is decreased until the heart function shows signs of becoming normal again. In rare cases hypodermoclysis may have to be employed if there is intolerance of fluids by mouth.

Most important among medical measures is the administration of Lugol's solution for 2 to 4 weeks previous to operation. It is now some 15 years since Plummer of the Mayo Clinic introduced the use of this compound iodine solution (free iodine 5 per cent, potassium iodide 10 per cent in 100 cubic centimeters of water) in treatment of hyperthyroidism. This has the effect of causing rapid involution of the hyperplasia and of reducing the goiter to a colloidal state, in part at least, thus making its removal easier and permitting greater thoroughness in operation. Its use has lessened the hazards of operation to a marked degree and has been one of the most important factors in eliminating the two to several stage operation formerly in almost universal use.

At the De Courcy Clinic all goiter patients, as a matter of routine, receive 10 minims of Lugol's solution 3 times a day for 2 to 4 weeks previous to operation, the time depending on the degree of clinical improvement observed and on the changes occurring in the gland itself as checked by metabolic readings. The immediate effects consist of relaxation of nervous tension, a control of toxic symptoms, a fall in the basal metabolic rate of 2 to 4 points daily, and increase of appetite and a sounder sleep. This improvement is only temporary, however, and must not be taken to indicate that operation has become unnecessary.

Boothby has shown in a series of graphs that the introduction of iodine previous to operation caused a drop in operative mortality from between 3 and 4 per cent to less than 1 per cent and reduced the number of stage operations from 50 per cent to 2 per cent, permitting subtotal thyroidectomy in a single operation to take their place.

The earliest moment of full iodization is not necessarily the optimum time to operate. The time of operation should be chosen on the basis of the patient's condition and not on any basis of a fixed time after the beginning of iodine administration.

For toxic thyroid patients, who exhibit severe signs of heart failure, thorough digitalization should be brought about. Patients are put to bed and given from 5 to 10 drops of tincture of digitalis 3 times a day according to the degree of

decompensation. This is usually discontinued 5 days before the operation. In these cases, if edema is present, fluids are restricted to not over 1 liter a day. In very severe cases preliminary blood transfusion may be a necessary prophylactic measure. Sedation must of course be administered to patients in a state of great nervous excitement. The preoperative use of iodine is doubly important in cases of patients in whom a psychosis is present, in view of the danger of its exacerbation immediately after operation.

The ideal time for operation is found when nervousness is overcome, weight either stationary or gaining, pulse rate below 100, and the basal metabolic rate less than plus 40. I feel that no operation should ever be undertaken while weight is still falling, since this means that catabolism overbalances anabolism and that consequently the thyroid function is too active for surgery.

In extremely toxic cases, or those patients in whom there is an excessively large goiter, it is sometimes still necessary to do a two stage operation especially if the patients do not improve under iodine medication.

#### IMMEDIATE PRE OPERATIVE PREPARATION

The patient receives a soap-suds enema on the evening before operation. By mouth 30 minims of Lugol's solution is administered at this time. Appropriate sedation is given to secure a good night's rest. The following morning  $1\frac{1}{2}$  to  $2\frac{1}{2}$  gram of morphine is given 1 hour before operation. This enables the patient to approach the time of operation in the perfect peace of mind that is indispensable for the best operative results. Rather liberal premedication is desirable to lessen the inevitable nervousness and excitement incident to the approaching ordeal in this type of patient.

#### ANESTHESIA

Since 1920 approximately 9,200 goiter operations have been performed at the De Courcy Clinic under various methods of anesthesia. After a thorough trial of local anesthesia in 500 cases and of ether and a number of other methods, we have given all of these up in favor of nitrous oxide and oxygen which we began to use in 1923. Among its many advantages are the rapidity with which it takes effect, the promptness of recovery, and the easy regulation of dosage. With this type of anesthesia it is possible to deepen or lighten at will the degree of narcosis. Postoperative vomiting is infrequent and postoperative hemorrhage very rarely occurs.

The chief disadvantage of local anesthesia which is favored by many on account of its lack

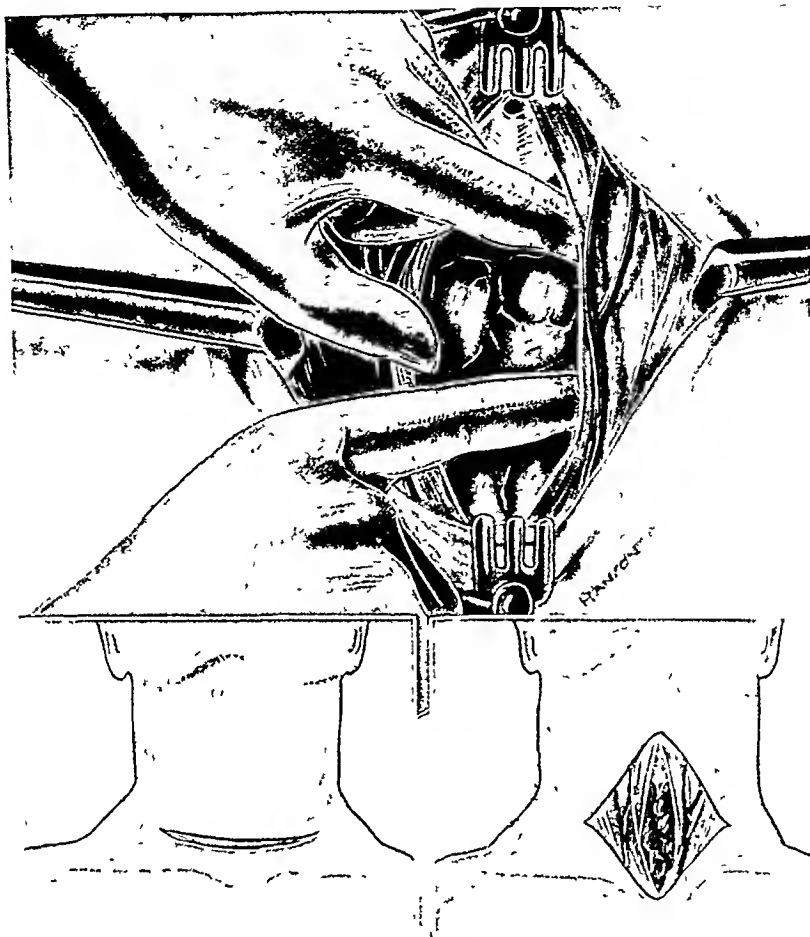


Fig 1 Lower left, incision through skin and platysma

Fig. 2 Lower right, longitudinal incision of fascia

Fig 3 Above, freeing of gland from overlying structures

of toxicity, lies in the fact that these patients, being very nervous and excitable, often cannot tolerate an operation done while they are in a conscious state. In addition, local anesthesia has often been found inadequate during the stage at which the lateral lobes of the gland are elevated, and the surgeon on the whole has less freedom for rapid manipulation.

Because of the frequency with which a damaged myocardium is present in these operations, an efficient airway is a *sine qua non* for their execution. This is best secured by the free flow of oxygen obtainable under nitrous oxide combined with oxygen, which can be given in any proportion desired and varied from one moment to another according to need.

#### OPERATIVE TECHNIQUE

1 With the patient in the recumbent position, the incision is usually made in one of the lower creases of the neck. It should, however, not be so low as to sag down at a later time below the natural lowest skin crease. Too much curvature is to be avoided. The knife should be drawn across the neck with an arm motion, which does not bend the hand at the wrist, so as to prevent a feathering of the skin margins and thus to permit a better connective result. The incision should be carried through the closely adherent platysma to facilitate blunt dissection (Fig 1).

Small bleeders or oozing spots in the skin flap are grasped with small hemostats and coagulated. This eliminates ligation which frequently becomes

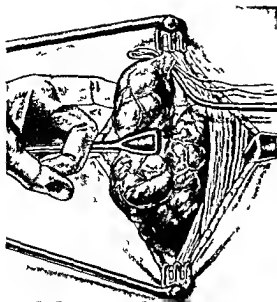


Fig 4 Ligation of superior pole

noticeable later because of cystic accumulation about the catgut.

Care should be taken to cut in the fascial plane between the platysma and fascia on the anterior surface of the ribbon muscles. In order to avoid severing the cutaneous nerves, which would result in later numbness and in paresthesias that sometimes occur from the chin downward, the skin flap should not be raised laterally more than just enough to make a V between the lateral ends of the incision and the highest point of the midline.

2 It is seldom necessary or desirable to sever the ribbon muscles but in the hands of a less experienced operator such a division may for a time be the safer course until greater proficiency is gained. In such case the division should be made high up and as near the larynx as possible in order to reduce the possible damage to the nerve supply of the upper portion of the muscle. After experience has been gained sufficient visualization is obtainable if the longitudinal incision of the fascia is carried well up over the laryngeal cartilage (Fig 2). Previous to the days of iodination, it was difficult to raise the hyperplastic gland and therefore necessary to divide the ribbon muscles.

Occasionally today we divide the muscles in very large substernal goiters or in those which because they are iodine fast, fail to undergo colloid involution. These indications are however relatively rare.

3 Blunt dissection over the gland with the fingers facilitates delivery. No attempt is made to go around the gland, because in doing this there is danger of tearing the lateral vein and also of traumatizing the recurrent laryngeal nerve (Fig 3).

A definite strip must be left on each side toward the back of the gland, in order to preserve intact the parathyroids and the recurrent laryngeal nerve. If by chance a parathyroid is damaged the accidentally dissected gland should be immediately reimplanted. One should avoid the removal of any fat like processes, since the exact position of the parathyroids is not always predictable. In the event of injury to the laryngeal nerve, revealed by a change in the type of breathing the nerve should be repaired at once if it is cut, it must be sutured. If a clamp is making pressure upon it, it must be removed.

4 Elevation of the right lobe can usually be accomplished to a point sufficient to apply the traction forceps by use of a mouse tooth tissue forceps. After applying this and elevating the lobe with the traction forceps, the sternothyroid muscle which is adherent to the side of the gland, is wiped down with a piece of gauze as the lobe is being elevated.

5 The superior pole is next dissected free and a double strand of No 2 chromic catgut passed above the pole and tied thus the superior artery is secured. Before the carrier is passed around the pole, the latter is elevated by passing the finger underneath and raising it (Fig 4).

Because of the close proximity of the superior laryngeal nerve, some surgeons feel that it is necessary to dissect out the superior artery and tie it under direct vision.

In doing a number of dissections on the cadaver I have found this to be unnecessary and undesirable for two reasons. First the artery frequently divides some distance above its entrance into the gland and there is some danger of injuring the nerve because of the added trauma. Second because of the poor exposure at this point retraction of the artery frequently occurs after the clamp is applied and makes ligation not only difficult but also hazardous, besides encouraging slipping of the knot with primary or secondary hemorrhage.

If the finger is passed under the superior pole and the pole is raised the carrier is passed only around the vessels and there is no danger to the nerve or the trachea. In the examination of 10 cadavers ligated in this manner with subsequent inspection the superior laryngeal nerve was not included in the ligation once.



Fig 5 Stripping right lobe across trachea

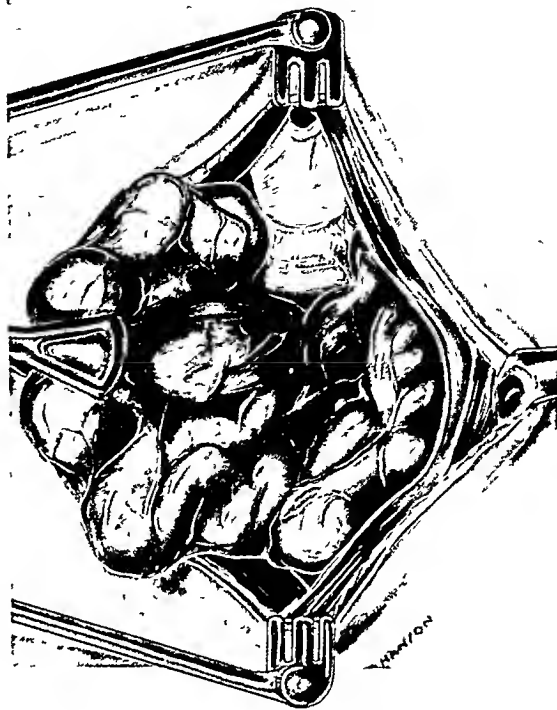


Fig 6 Elevation of left lobe by traction upon right lobe after trachea has been dissected free

6 After elevation of the right lobe and ligation of the superior artery, the superior pole is incised with a knife proximal to the ligature. This incision facilitates further elevation of the gland and permits a more even dissection, thereby lessening the chance of leaving too much glandular tissue at the superior pole, which would favor a recurrence at this site.

Straight mouse-toothed hemostats are applied along the side of the gland at right angles to the trachea. These hemostats clamp the branches of the inferior artery and veins as they penetrate the gland. The trunk of the inferior artery is not exposed. I still feel that the ligation of this trunk lessens or entirely destroys the blood supply to the parathyroid bodies and encourages tetany.

The amount of gland to leave is always a controversial question. It is better to remove too much than too little, because the remaining portion will usually hypertrophy to a point sufficient to maintain normal body metabolism. As a rule, in my opinion, not less than four-fifths of the gland should be removed if thyrotoxicosis is to be relieved, but, of course, the amount varies with the individual case. A practical way is to

place the hemostats so that they will lie on a plane with the anterior surface of the trachea if the gland is elevated at the time the clamps are placed.

7. The right lobe is then dissected from without inward until the trachea is reached. The surgeon then usually disregards the right lobe and proceeds to dissect the left lobe, leaving the trachea until the last.

Instead of doing this, I continue the dissection of the right lobe right across the trachea and slightly under the left lobe. When the trachea is reached, a little traction discloses a line of cleavage, and dissection of the isthmus is greatly facilitated without damage to the trachea (Fig 5).

8 After the trachea is crossed, traction upon the right lobe and isthmus automatically lifts the left lobe from its bed and in this way eliminates the trauma which is sometimes required during the effort to raise the left lobe. By this method it is usually possible to elevate both lobes with thumb forceps only (Fig 6).

9 After subtotal thyroidectomy the clamped vessels are ligated individually with No. 2 chromic gut. If it is thought necessary, some of the sutures may be anchored. No attempt is made to close

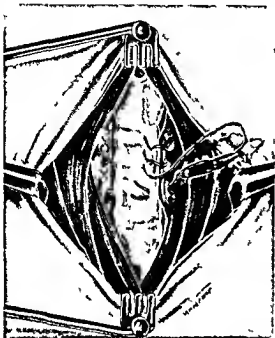


Fig 7 Suture of sternothyroid muscle to pretracheal fascia

over the anatomical capsule of the gland. Instead the sternothyroid muscle is sutured on either side to the pretracheal fascia with No. 6 plain catgut (Fig. 7). This muscle not only acts as a hemostatic agent over any seepage from the gland surface but prevents any overlying adhesions to the gland itself as well.

Since we have been doing this we have eliminated drainage in all but the very exceptional case in which a large cavity remains after removal of the substernal goiter.

In our last series of 2,000 cases we have not drained thyroidectomy wounds with very few exceptions (less than 1 per cent) and have thereby lessened the convalescent period very perceptibly.

10 The ribbon muscles are next sutured vertically and the skin closed with clips, to be removed in 72 hours (Figs. 8, 9, 10).

The principal accidents to be guarded against are hemorrhage, injuries to the parathyroids or to the recurrent laryngeal nerve, collapse of the trachea, and air embolism through the large veins of the neck. If a scrupulous technique is observed none of these is likely to occur. In the event of a collapse of the trachea tracheotomy must be done instantly.

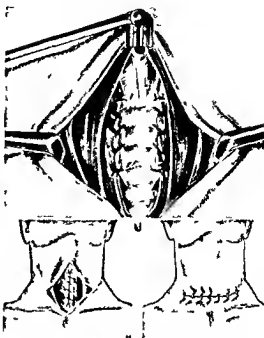


Fig. 8 Above sternothyroid muscle sutured to pretracheal fascia.

Fig. 9 Lower left longitudinal incision of fascia sutured.

Fig. 10 Lower right skin incision closed.

#### POSTOPERATIVE CARE

The postoperative treatment of goiter cases has been tremendously simplified since the introduction of pre-operative iodine treatment. In most cases there is immediate improvement consisting of relief of tachycardia, muscular tremor, restlessness, and fever.

The patient is put to bed in a comfortable position and watched closely for complications. Lugol's solution is as useful after operation as it was before. In the average case the patient receives 10 minims every 8 hours, beginning as soon as he is brick in bed. In all toxic cases, however, he is given 30 minims by rectum upon his return to bed and this is repeated 8 hours later. In rare cases a third large dose is given. Fluid is administered subcutaneously and may be taken by mouth if there is no vomiting. Application of warmth and administration of sedatives are necessary. Oxygen may be required and the oxygen tent should be in readiness for such emergency.

In cases of extreme prostration transfusion may be necessary. In the event of a thyroid crisis—now happily a rare occurrence since the introduction of Lugol's solution pre-operatively—iodine

and quinine hydrobromide are immediately given with intravenous glucose, oxygen, and refrigeration. If signs of tetany occur, parathyroid Collip extract and calcium lactate should be in readiness. In the average patient, however, none of these emergencies arise and the patient makes an uneventful recovery.

#### AMOUNT OF GLAND TO REMOVE

The question of how much thyroid tissue to remove is far from being purely academic.

If too little is removed, the result is a continuance or recurrence of thyrotoxicosis. Many patients will never be persuaded to undergo a second operation, even though it be greatly needed. In such cases it is important to do a radical operation from the start. If, through fear of giving rise to myxedema, too little gland is removed, it may be impossible ever to persuade the patient to return again. This should impress upon us the realization that an ineffective operation means a defeat to surgery.

On the other hand, the removal of too much thyroid tissue invites myxedema, which may involve personality changes. The general consensus is that too much should be removed rather than too little, since the probability is that the gland will grow again to some extent and will thereby replace lost tissue, and thus myxedematous changes will be prevented.

Lahey, who has given close attention to this problem, concludes that a correct decision can be made on the basis of the degree of involution that has been brought about before operation by Lugol's solution. In the case of patients on whom this iodine involution is of high degree, as judged by gross appearance (pale, edematous tissue), he would remove relatively less tissue, in order not to impair the reproductive ability of what is left, which is now small. In patients in whom involution is of low degree, with a brownish red and cellular appearance of the tissue, he would remove a large quantity, lest its reproduction be too easy, resulting in return of excessive thyroid activity.

According to Pool and Garlock, there seems little doubt that the occasional thyroid surgeon, not a specialist, will have a high recurrence rate, because of inadequate removal of this gland. He is afraid of injuring the parathyroids and the

laryngeal nerve, and in addition he has not yet developed a standard procedure. He may therefore expect many recurrences before he has learned to operate efficiently and adequately in this disease. Pool and Garlock themselves report a recurrence rate of 93 per cent in a series of 171 primary resections.

My own conviction is that it is much better to remove too much than too little of the thyroid gland, since we have very good means now of combating hypothyroidism by thyroid feeding, whereas hyperthyroidism can thus far be overcome only by surgical means. As already pointed out, the patient is with difficulty persuaded to return for repetition of a procedure that has already failed to bring relief.

#### SUMMARY

1. It was chiefly the arrival of the artery clamp that made possible the modern surgical treatment of goiter.
2. General surgeons should equip themselves more generally to perform this important operation.
3. The surgical technique of subtotal thyroidectomy is presented.
4. It is safer to remove too much than too little of the hyperplastic thyroid gland.

#### BIBLIOGRAPHY

1. BOOTHBY, W. M. Disease of the thyroid gland, interpretative review of progress toward solution of problem. *Arch Int Med*, 1935, 56: 136-206.
2. DIEFFENBACH, J. F. Die Operation des Kropfes. *Die Operative Chirurgie*, Leipzig, 1848, pp. 331, 340.
3. GROSS, S. D. A System of Surgery, Vol. 2, 4th ed. Philadelphia, 1866, p. 394.
4. HALSTED, Wm. S. The Operative Story of Goitre, In *Johns Hopkins Hosp Rep*, 1920, 19: 71-258.
5. LAHEY, F. H. How much thyroid tissue should be removed in toxic goiter? *Ann Surg*, 1932, 95: 529.
6. LISTON, R. Lectures on the Operations of Surgery and on Diseases and Accidents Requiring Operations. Philadelphia, 1846, p. 318.
7. MILLER, C. C. Safeguarded Thyroidectomy and Thyroid Surgery. Philadelphia: F. A. Davis Co., 1928.
8. PLUMMER, H. S. Results of administering iodine to patients having exophthalmic goiter. *J Am M Ass*, 1923, 80: 1955.
9. POOL, E. H., and GARLOCK, J. H. Surgical treatment of exophthalmic goiter, late end-results. *Surg, Gynec & Obst*, 1934, 59: 330.



# A STUDY AND END-RESULT REPORT OF SEVENTY ARTHROPLASTIES AND RECONSTRUCTION OPERATIONS ON THE HIP JOINT

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**A** STUDY has been made of all the arthroplasties and reconstruction operations of the hip joint that have been performed at the New York Orthopedic Dispensary and Hospital from August 1916 to October, 1934.

Seventy five operations have been done on 71 patients. In 2 of the patients a second mobilizing procedure was done on the same hip and in 2, bilateral operations were performed but at different times.

Five patients were followed for less than 1 year for reasons outside of our control. This leaves 70 operations in which there has been a follow up examination of 1 year or more. The longest follow up time was 12 years and the average was 3.5 expressed as case years, the average time was 4.

No selection of patients for operation was made, provided that there were present severe enough symptoms to warrant major surgery and that the cause of the disability was such as to make a mobilizing procedure proper. In many the degree of joint damage was staggering such as complete destruction of the head and neck and dislocation of the femoral shaft upon the ilium or tremendous overgrowth and deformity of the head with degeneration of cartilage and obliteration of the joint space. By operation it was hoped to give these distressed patients stable hips that were free from pain and that had adequate ranges of mobility.

## ETIOLOGY

The cases were divided according to history and x-ray findings into the following groups: osteo-arthritis, 18 cases, osteo arthritis following trauma without fracture 2, osteo-arthritis following fracture, 3, osteo-arthritis following non specific synovitis, 1, rheumatoid arthritis, 2, infectious arthritis, 2, arthritis or ankylosis due to the gonococcus, 3, residual adolescent slipped epiphysis, 6, residual coxa plana or magna 8, fibrous ankylosis following operative procedures 3, stabilization of old congenital dislocation of the hip

1, ununited fracture of the femoral neck, 1, residual suppurative arthritis, 20 a total of 70 cases.

The 3 cases of osteo-arthritis resulting from fracture followed a compression fracture of the upper portion of the femoral head, a fracture of the acetabulum with posterior dislocation of the hip and a fracture of the neck with malunion.

The 2 cases of infectious arthritis followed respectively scarlet fever and phlebitis. Suppuration did not occur.

The gonorrheal cases included 2 with fibrous and 1 with bony ankylosis.

The 3 cases of fibrous ankylosis following operations resulted from open reductions 2 for congenital dislocation of the hip and 1 for adolescent slipped epiphysis.

The 20 cases of residual suppurative arthritis are from the standpoint of therapy a formidable group. Half of them presented dislocation following destruction of the femoral head and neck, and 3 had bony ankylosis. One case thought to be pyogenic in origin was proved later by microscopical section to be tuberculous. In this patient fusion has been obtained and an excellent result with complete subsidence of the disease.

## AGE AND DURATION OF SYMPTOMS

The ages of the patients at operation varied from 18 months to 66 years. The average was 29 years.

The duration of symptoms prior to operation ranged from 18 months to 26 years and averaged 6 years.

## SYMPTOMATOLOGY

The patients complained of pain, limitation of motion, instability, deformity and shortening.

**Pain.** Fourteen patients had no pain before operation. 6 of these suffered dislocations. 1 was only slightly over 2 years of age and had almost a dislocation (residual suppurative arthritis), 4 had bony ankylosis and 3 had fibrous ankylosis that allowed slight or no motion at all.

Four patients had pain estimated as 1 plus in seventy (scale 0 to 4 plus), 12 2 plus, 26 3 plus and 10 4 plus. No pre-operative note was made in 4. The average amount of pain was 2 plus.

*Limitation of motion* In order to express completely and simply the entire range of mobility present in any given hip joint, the index of function was employed that was described by Ferguson and Howorth.<sup>1</sup> To obtain this index, the degrees of motion present in each arc of mobility are multiplied by a suitable factor, the size of which depends upon the relative importance of that particular arc for function of the hip as a whole. The products are added and the sum is the index of function. The factors chosen were: for flexion 0.4, for extension 0.1, for abduction 0.4, for adduction 0.2, for internal rotation 0.2, for external rotation 0.1. The normal hip has an index of from 90 to 110. Table I is an illustration

TABLE I—EXAMPLE

Arc of motion	Degree of motion	Factor	Product
Flexion	145	0.4	58
Extension	10	0.1	1
Abduction	45	0.4	18
Adduction	30	0.2	6
Internal rotation	30	0.2	6
External rotation	60	0.1	6
Index of function			95

## EXPRESSED IN GENERAL TERMS

	Degrees
Hypermobile	Over 110
Normal	90-110
Good	60-90
Fair	50-60
Indifferent	40-50
Poor	30-40
Bad	Under 30

Excluding for reason of simplicity, the patients with dislocation (13, 12 before operation and 1 after), the index of function before operation ranged from 0 to 57 and averaged 21. Expressed in general terms, the indices of motion were distributed as shown in Table II.

TABLE II

	Cases
Normal (Index of 90-100)	0
Good (Index of 60-90)	0
Fair (Index of 30-60)	22
Poor (Index of 1-30)	28
No motion (0)	7

*Instability* Twelve patients presented dislocations before operation. Ten of these were the result of suppurative arthritis, 1 was a fracture dislocation and 1 was a congenital dislocation complicated by poliomyelitis.

*Deformity* Some degree of deformity was the rule. Flexion deformity was noted before opera-

tion in 52 instances and lateral deformity, usually adduction, in 37. Severe flexion deformity (over 35°) occurred 14 times and pronounced adduction (over 10 degrees) 15 times.

*Shortening* Shortening was noted before operation in 51 patients and the average amount was 0.9 inch. Eighteen of these were suppurative cases and their average shortening was 1.5 inches. The average shortening in the remainder of the patients was 0.4 inch.

In one or two instances, due to an accompanying pathological process in the opposite hip, the shortening was present on the side not operated upon.

## THE OPERATIVE PROCEDURES

The operative procedures varied a great deal. This variation in technique was due in part to the fact that the operations were performed by 8 or 10 different surgeons, but in general the type of technique was determined by the conditions found upon exposure of the joint.

All of the operations were of a plastic nature and can be called arthroplasties, but, in the sense that an arthroplasty attempts to provide a newly constructed joint with as near the normal form and structure as possible and with interposed tissue or artificial membrane, most of the procedures must be termed reconstructions. The two terms, however, are used in this study interchangeably.

When the femoral head was enlarged, overgrown, or deformed, it was the custom either to trim and shape it, thus reducing it in size and sometimes depth, or to remove it completely, thus allowing the rounded end of the neck to engage in the acetabulum. When the femoral head had been destroyed, the end of the neck was reshaped and placed in the acetabulum and the trochanter was usually transplanted to a lower level on the shaft, or was split out laterally to increase the leverage of the abductor muscles and to increase the bearing surface of the superior aspect of the neck. When the femoral neck had been completely or subtotally destroyed, a so called bifurcation operation was used in which the upper end of the femoral shaft was split longitudinally, the medial half reduced into the acetabulum and the outer or trochanteric portion green-stick fractured outward and held in position by bone fragments placed in the cleft.

When the acetabulum was shallow, it was made deeper by curetting or gouging, sometimes to bone. Osteophytic ridges on the margins of the acetabulum were removed.

Usually no interposed tissue was considered necessary but Baer's membrane was used twice,



Fig 1 C W Absorption and sequestration of epiphyseal bone following extensive partial resection of the femoral head in a case of bony ankylosis following gonorrheal infection in a girl aged 16 years a Immediately after operation After separation from the acetabulum the head was reduced in size to the diameter of the neck A double layer of fascia lata was interposed Motion was begun in 2 weeks b Four months after operation Aseptic sequestration has occurred superiorly in the head and absorption inferiorly c Three years after operation The sequester was removed 8 months after the arthroplasty Pre operative pain 0 3 years after operation 2 plus Pre operative index of function 0 3 years after operation 26

a single layer of fascia lata 4 times, a double layer 4, and a pedicle fibrous tissue flap once

In 1 patient (with compression fracture of the head with resultant osteo arthritis) the operation consisted only of a removal of loose bodies from the acetabulum and a covering of the head with a single layer of fascia lata In 1 of the cases of residual suppurative arthritis in which the head and some of the neck had been destroyed a shelf of bone was turned down from the thum to overlie the reduced and reshaped upper end of the femoral shaft In a case of bony ankylosis following suppurative arthritis, the end of the femur was chiseled free and made to articulate beneath a narrow shelf or ridge left on the thum In a patient who had a painful fibrous ankylosis following gonorrheal infection, the proximal portion of the femoral head was inadvertently left in the acetabulum The neck was covered with fascia and reduced The remnant of head became fused to the acetabulum, but motion was retained between the head and the neck and this has turned out to be one of the best results

The femoral head was trimmed reshaped, reduced in size and sometimes depth in 24 instances it was completely or subtotally ( $\frac{3}{4}$  or more) removed in 25 The acetabulum was curetted deepened "excavated" or gouged in 21 patients In



Fig 2 V V Aseptic sequestration of the femoral head following extensive partial resection at arthroplasty in a young woman aged 24 years with chronic infectious arthritis of the hips The head was reduced to one half its size and the trochanter was transplanted Motion was started at 5 weeks Sequestration of epiphyseal bone occurred but the sequester eventually reunited to the neck a Six months after operation The line of sequestration is visible b Three years after operation The sequester is present and is of increased density c Six years after operation The sequester has reunited to the neck Pre operative pain 3 plus 6 years after operation 1 plus Pre operative index of function 5 6 years after operation 8

2 of these the records state that bone was exposed after the gouging or curetting and in 1 a new acetabulum made out of solid bone The greater trochanter was transplanted or split out 51 times

**Postoperative treatment** Usually plaster immobilization was maintained for from 3 to 6 weeks after operation This was done chiefly to allow the transplanted trochanter to become firmly united before motion was begun In 9 patients for reasons not stated in the histories plaster casts were kept on for several months Seven of these were patients with residual suppurative arthritis accompanied by dislocation and in whom the danger of redislocation was probably great

The average time that motion was begun after operation was 6.5 weeks In 7 motion was started within 2 weeks The average pre operative index of these 7 was 10, and at follow up 24 All the gain occurred in 4

Physiotherapy was continued for as long as possible after the patient had left the ward Its duration was of course subject to great variation

#### COMPLICATIONS

Fortunately there were not many complications Four deep wound infections occurred Two of these were in residual suppurative cases In one of the latter *Staphylococcus aureus* was cultured at the time of operation The original infection in this case had occurred 8 years prior to

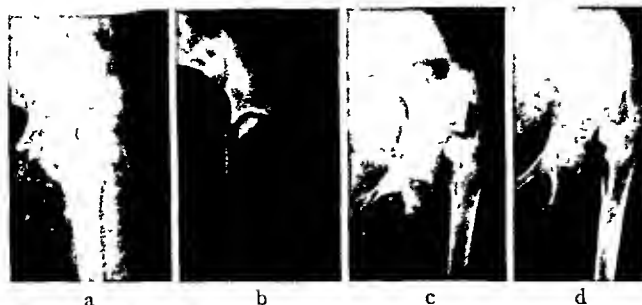


Fig 3 M C Sequestration and absorption of femoral head following partial resection in an arthroplasty on a girl aged 8 years who for 1 year had had a stiff hip after open reduction for congenital dislocation. The head was reshaped and the upper part of the acetabulum was enlarged. A double layer of fascia lata was interposed. The trochanter was not transplanted. Motion was begun in 2 weeks. a, Immediately after operation. b, One month after operation. The head has separated from the neck. c, Seven months after operation. The head is absorbing and the neck and shaft have subluxated. d, Fifteen months after operation. Further absorption of the head has occurred. The femur has subluxated. Pre-operative pain, 0, 3 years after operation, 0. Pre-operative index of function, 0, 3 years after operation, 32.

arthroplasty and all sinuses had been closed for 5 years. Four patients developed sinuses. Two of these occurred in the 2 residual suppurative cases with wound infections. Other complications were massive skin flap necrosis, 2 cases, stitch abscess, 1, superficial wound infection, 1, hematoma, 1, non-fatal pulmonary embolus, 1.

#### SUBSEQUENT OPERATIONS

Eight patients subsequently had hip fusion operations because of failure of the arthroplasty. In 2 patients a transplantation of the trochanter to increase abductor muscle leverage was done, in 1 a re-attachment of a trochanter that had pulled loose, in 1 a shelf stabilization for failure to achieve stability following reconstruction for residual suppurative arthritis with dislocation, and in 1 removal of an aseptic sequestrum from the femoral head. In addition, a few hip stretchings or mobilizations under anesthesia were performed.

#### RESULTS

**Mortality.** There were no operative deaths but 2 patients have subsequently died: 1 of carcinoma of the ovaries 5 years after arthroplasty, and 1 of nephritis 6 years after arthroplasty.

**Pain.** The average amount of pain before operation was 2 plus, at follow-up examination, 1 plus. Twenty-six patients had no pain after operation, 21, 1 plus, 11, 2 plus, 5, 3 plus, and 3, 4 plus. No note was made in 4. Fourteen of the patients before operation had no pain. At follow-up, 10

of these were still free of pain, 2 had 1 plus and 1 had 2 plus pain. No note was made in 1. Fifty-two of the patients before operation had painful hips. At follow-up, 14 of these were free from pain and 36 were still painful (no note in 2). Of the 39 that were painful after arthroplasty, 26 were less painful than before the operation, 5 were more painful and 8 were the same (Table III).

TABLE III —RESULTS AS TO PAIN

Average pain pre-operatively	2 plus 1 plus	
Average pain at follow-up	Before operation cases	At follow-up cases
No pain	14	26
1 plus	4	21
2 plus	12	11
3 plus	26	5
4 plus	10	3
No note	4	4
	70	70
Hips painless before operation		14
Results: No pain, 10, pain, 3, no note, 1		
Hips painful before operation		52
Results: no pain, 14, pain, 36, no note, 2		
Hips painful after operation		39
Less painful than before operation, 26, the same, 8, more painful, 5		

**Mobility.** The average index of function before operation was 21, at follow-up examination 18, all patients with dislocations (13) being excluded.

Expressed in general terms, the follow-up indices after operation were distributed as follows:

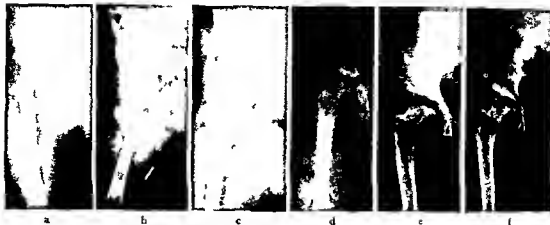


Fig 4 L. C. Arthroplasty for residual suppurative arthritis with dislocation in child aged 1½ years. At operation the acetabulum was deepened exposing bone. The end of the femoral neck was trimmed. The trochanter was braced outward from the neck ¼ inch and supported in position by a bone transplant. Motion was begun in 6 weeks. The series of roentgenograms shows the joint changes that occurred over a period of 5 years. Before operation the patient was free from pain, but dislocation

was present and the index of function was 00. Six years after operation she had no pain, the index was 60 and reduction of the dislocation had been maintained. a The pre-operative condition. b Two months after operation. c Six months after operation. d Fourteen months after operation. Absorption is beginning at the articular surface of the neck. e Three years after operation. f Five years after operation. Absorption is more marked.

normal (index 90-100), 0, good (index of 60-90), 2 fair (index of 30-60), 11, poor (1-30), 34, no motion (0), 0, no note, 1.

The index of function was improved in 29 per cent (16 patients) and the average gain was 22, it was lowered in 39 per cent (72 patients) the average loss being 20, it was changed by less than 5 or not affected in 32 per cent (18 patients).

Comparison with the pre operative condition is made in Table IV.

TABLE IV — RESULTS AS TO FUNCTION  
DISLOCATED CASES EXCLUDED

Average index before operation	21	
Average index at follow up	18	
	Before operation	At follow up
Normal motion (90-100)	0	0
Good motion (60-90)	0	2
Fair motion (30-60)	22	11
Poor motion (1-30)	28	34
No motion (0)	7	9
No note	—	1
	57	57
	Cases	Per cent
Index improved	16	29
Index lowered	22	39
Index unaffected	18	32
Average gain in index	22	
Average loss in index	20	

Thirty five patients had pre operative indices of from 0 to 30, and 22 of from 30 to 60. The aver-

age follow up index for the former group was 11 and for the latter 30. These figures indicate that in general those patients with fair ranges of mobility before operation retained fair motion after and that those with poor mobility finished with little motion.

*Relation of pain to mobility after operation.* Absence of motion by bony fusion or tight fibrous ankylosis occurred more often in the hips that at follow up examination were not painful (31 per cent of 26) than in those that were (3 per cent of 40). This indicates that absence of motion was probably a factor in the number of hips that were eventually free from pain after arthroplasty was performed.

*Results as to pain and mobility in relation to etiological groups.* The number of patients in most of the groups is so small that no conclusions can be drawn except in the divisions of osteo-arthritis and residual suppurative arthritis. In the former group of patients alleviation of average pain occurred (average before operation 3 plus after, 1 plus) but motion in general was somewhat decreased (average pre operative index, 28, post operative 23). In the latter group average pain was unaffected (average before operation ½ plus after ½ plus) and motion was generally lost (average pre operative index 20 patients with dislocations 40 postoperative 4 patients with dislocations 15).

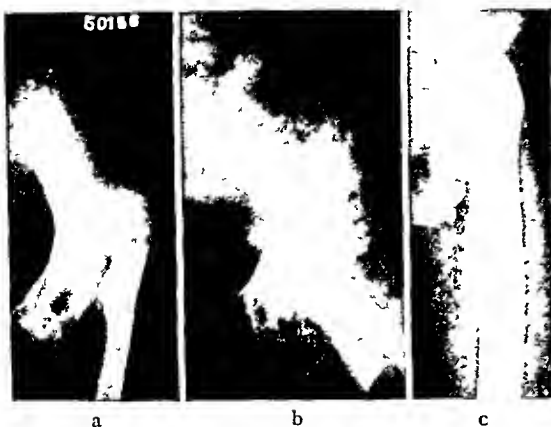


Fig 5 R B Residual suppurative arthritis with dislocation in a girl aged 17 years. The original infection occurred at the age of 1 year. At operation, fibrous tissue was removed from the acetabulum, the trochanter was removed and transplanted, and the intertrochanteric portion of the femoral shaft was placed in the acetabulum. Motion was started at 7 weeks. The end-result was fusion of the joint. a, Before operation. b, Immediately after operation. c, Five years after operation.

**Dislocation** Dislocation was cured in 8 of the 12 patients that presented this complicating abnormality before operation. Four remained uncured. The average pre-operative index was 73 and at follow-up 37. Excluding the 4 patients with residual dislocations the average follow-up index was 27. A good deal of mobility was therefore sacrificed for stability. One patient (an osteo-arthritis) with no dislocation before operation suffered a dislocation several years after.

**Deformity** Flexion deformity after operation was recorded in 37 instances and lateral deformity in 38. Severe flexion deformity (over  $35^{\circ}$ ) occurred 7 times (14 times before operation) and pronounced adduction deformity (over  $10^{\circ}$ ) 3 times (15 times before operation). Three patients with less than 35 degrees of flexion deformity before, had more than 35 degrees after operation, and 2 patients with slight adduction deformity before had excessive adduction after.

**Shortening** Shortening was noted at follow-up examination in 26 patients and the average amount was 1.5 inches (0.9 inch before operation).

**Results in those with bony ankylosis.** Of the 4 patients who had bony ankylosis before operation, 3 from suppurative arthritis and 1 from gonorrhea, 3 presented bony ankylosis at follow-up and 1 (the neisserian infection) mobility with an index of 26. The last, however, had pain.

**Effect of interposed tissue.** As already stated some form of interposed tissue, usually fascia



Fig 6 H B Arthroplasty for residual gonorrheal arthritis in a male aged 29 years. It was intended at operation to remove the entire femoral head but the proximal portion was inadvertently left in the acetabulum and the pointed end of the neck was placed against it, but separated from it by a double layer of fascia. Motion was begun in 4 weeks. The remnant of head eventually became fused to the acetabulum, but a good range of motion without pain was preserved between the fused portion of head and the neck. a, The pre-operative condition. b, One month after operation. c, Two and one-half years after operation. Pre-operative pain, 1 plus, 3 years after operation, 0. Pre-operative index of function, 4, 3 years after operation, 56.



Fig 7 E F Arthroplasty in a woman aged 40 years for osteo-arthritis following an old coxa plana. The head was removed and the remodeled end of the neck was placed in the acetabulum. The trochanter was not transplanted and interposed tissue was not used. Motion was begun within a few days, but had to be discontinued because of the occurrence of several non-fatal pulmonary emboli. At 8½ weeks, the patient was walking with crutches. a, Before operation. Note the tremendous amount of structural deformity present. b, Three years after operation. Pre-operative pain, 4 plus, 3 years after operation, 1 plus. Pre-operative index of function, 32, 3 years after operation, 31.

lata, was employed in 11 patients whose average pre operative index was 10. Five gained in index by 26, 32, 28, 52, and 5, respectively, 2 lost by 14 and 36 and 4 were unaffected or changed by less than 5. The average postoperative index was 18.

*Effect of the amount of bone removed from the femoral head.* It has been observed by Albert Ferguson that it is not safe to remove more than one third of the circumference of the femoral head because absorption of the remaining portion will often occur, which may materially and probably adversely affect the end result (Figs. 1, 2, and 3). Therefore, if circumstances demand that more than that amount be resected, it is wiser to remove the head completely and to reshape the end of the neck for articulation with the acetabulum.

#### THE DEVELOPMENT OF A BETTER OPERATIVE TECHNIQUE

From a study of these cases certain principles of arthroplasty have been derived:

1. More than one third of the circumference of the femoral head must not be removed if conditions demand the resection of more bone, the femoral head should be removed completely.

2. The remodeled head or neck should preferably be covered with a double layer of fascia lata.

3. The trochanter should not be transplanted at the time of the reconstructive procedure. It is left intact so that motion can be begun immediately (This does not apply to patients who have practically no femoral neck in which the trochanter, at the time of operation, must be removed or propped out in order to provide a femoral bearing surface to articulate with the acetabulum.)

4. Motion must be started immediately or within 2 or 3 days of operation and physiotherapy must be continued for many months after.

5. A proper selection of cases must be made, if good results are to be anticipated. Lazy or in different individuals or those with a low threshold value for pain are not good subjects for arthroplasty. Patients who have had ankyloses for years and consequently, have markedly atrophied muscles which cannot possibly function after mobilization of the joints, or those who present gross damage or tremendous deformity of structure, usually will not obtain good results.

Since October 1934 10 patients have been operated upon with these principles in mind. All have been examined a year or more after operation and the results have been most encouraging. The trochanter has been transplanted at a second operation in 1 patient because there was insufficient length of neck for a stable joint. One pa-

tient has sustained a dislocation following a severe and deep operative infection. The patients have good ranges of motion with a substantial gain in the index in every instance, and in general have decreased pain.

It must be borne in mind, however, that pronounced pain and limp may persist after a mobilizing operation. Before an arthroplasty is performed therefore the patient should thoroughly understand this fact and be willing to accept this possibility in order to obtain or preserve mobility. A fused hip, however in optimum position and in unilateral cases gives a beautiful end result, providing a painless, stable extremity, without marked limp, that can be relied upon for full use. Consequently, in many instances, hip fusion may be the operation of choice.

#### SUMMARY

1. A study of all the arthroplasties and reconstruction operations on the hip joint that have been performed at the New York Orthopedic Dispensary and Hospital from August, 1916 to October 1934 has been made.

2. The terms "arthroplasty" and "reconstruction" are used interchangeably in this study to denote a mobilizing procedure.

3. Seventy five operations have been done on 71 patients. Five cases for reasons outside of our control were followed for less than 1 year. This leaves 66 patients with 70 operations that have had a follow up examination of more than 1 year. The longest follow up time is 12 years and the average is 3.5 or 4 case years.

4. The average amount of pre operative pain was 2 plus (scale 0-4 plus) and the average amount at follow up was 1 plus.

5. The average functional index before operation was 21 and at follow up examination 18. The index was improved in 29 per cent with an average gain of 22. It was lowered in 39 per cent with an average loss of 20 and it was unaffected in 32 per cent.

6. Twelve patients presented pre operative dislocation. This was cured in 8 but at the sacrifice of a good deal of mobility. One patient who did not have a dislocation before operation had one 2 or 3 years later.

7. Certain principles of arthroplasty that have been derived from the study of these cases are stated. These have changed the technique of operation since 1934.

8. With these principles in mind much better results have been obtained in 10 patients that have been so operated upon and followed for more than 1 year.

# THE USE OF LIVING SUTURES OF THE EXTERNAL OBLIQUE APONEUROSIS IN THE REPAIR OF INGUINAL HERNIAS IN ADULTS

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IT IS the purpose of this article to report an operative technique for the repair of inguinal hernias and to propose the routine use of fascial sutures in the repair of inguinal hernias in adults

Several autoplasmic operations have been reported. The original one was devised by McArthur and reported by him in 1901. He employed the Bassini principle of repair but used pedicled strips of the external oblique aponeurosis as sutures to approximate the conjoined and Poupart's ligaments and to reapproximate the cut edges of the external oblique aponeurosis. The technique here described differs from the McArthur operation in that it incorporates a detail which I believe contributes much security, particularly in the repair of that group of hernias which have inadequate but not totally deficient support in the superpubic portion of the inguinal triangle. These include direct and combined direct and indirect, or saddle bag, hernias in which the aponeurosis of the internal oblique inserts into the pubis or sufficiently low that it can be approximated to Poupart's ligament without much tension and also the indirect hernias which have lost their obliquity because the internal rings extend down to the pubis.

This detail consists of utilization of the triangular fascia, the ligamentum inguinale reflexum—Colles's ligament—to obturate completely the small triangular defect which is left between the pubic spine and the lowermost approximating stitch in the classical operations.

Although utilization of this band of fascia in repair has been referred to in the literature, it is my impression that its existence, or at least its importance, is not adequately appreciated. This ligament is reflected from the external oblique fascia over the anterior superior aspect of the pubic spine in intimate contact with the periosteum and is continuous with Poupart's ligament laterally. Its free border superiorly forms a hood which can be lifted sufficiently to receive one suture to approximate it to the internal oblique or conjoined tendon. This firmly closes the vulnerable area immediately above the pubic spine.

Failure to obliterate this defect is responsible for many recurrences, inasmuch as the hernial sac or a diverticulum from a direct hernial bulge is protruded through the defect and provides an effective dilating wedge which enlarges the defect and breaks down an otherwise efficient support.

## TECHNIQUE

The usual oblique hernial incision is made over the inguinal canal and is extended inferiorly sufficiently to expose the anterior surface of the pubic spine and superiorly to expose the musculo-aponeurotic juncture of the external oblique muscle. Beginning with the external ring the external oblique aponeurosis is incised over the canal. The edges of the fascia are held apart by retractors to preserve this tissue undamaged for use subsequently as sutures. As the cord is lifted from the canal, the cremasteric fibers and transversalis fascia are dissected from it. The sac in all indirect hernias and the diverticulum in direct hernias (when present) are opened, dissected free down to the neck, and excised. The neck of the sac is ligated as high as possible. This, I believe, is a very important step because failure to do so leaves a cone which acts as a dilating wedge responsible for some recurrences. The transversalis fascia, the lateral border of the internal oblique muscle, and its aponeurosis, and the shelving fold of the external oblique fascia are widely exposed and wiped free of fat. It now becomes necessary thoroughly to expose the superior and anterior surfaces of the pubic spine and the transversalis fascia, and to clean both surfaces of the exposed portion of the external oblique fascia of fat.

As illustrated in Figure 1, a strip approximately 1.5 centimeters wide is cut from the superior mesial flap of the aponeurosis of the external oblique, severing it at the musculo-aponeurotic juncture above but leaving it attached below. It is important to free it down to the inferior border of the pubic spine. Usually it is possible to obtain a strip of 18 centimeters or longer. The free end is fastened to a fascial needle. I use an atraumatic needle of my own design, described elsewhere.



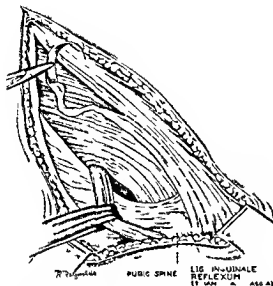


Fig 1 Illustrated are certain essential technical details. The anterior and inferior surfaces of the pubic spine are exposed in order to develop the triangular fascia and to permit freeing of the strip of external oblique aponeurosis to a level below the triangular fascia. The line of incision is indicated by the broken line. The free end of the suture has been fastened to the author's needle which is described in an article now in press (2). The stump of the hernial sac and the tissues in the floor of the canal were blacked out in the drawing to emphasize the borders of the inguinal triangle.

and shown in Figures 1 and 2. Since this needle does not require doubling of the fascia in threading, it obviates the difficulty and the tearing and trauma from dragging a bulky mass of fascia through tissues. The end of the fascial strip is inserted between the flanges in the head of the needle where it is secured with a suture of fine silk passed through drill holes. The needle threaded with fascia is first passed through the triangular ligament from below and anteriorly, and then into the internal oblique (conjoined) tendon lying immediately posterior and mesial to the triangular ligament. It is next passed through Poupart's ligament at its juncture with the triangular ligament and then continued as a continuous suture approximating Poupart's ligament to the transversalis fascia and to the internal oblique muscle and its tendon.

By inclusion of the transversalis fascia in each stitch the floor of the inguinal triangle is narrowed and strengthened and the internal ring with the cord is displaced upward more effectively. The end of the fascial strip is then anchored to the

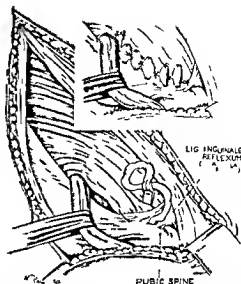


Fig 2 The fascial suture first seals the superpubic area by passing over the pubic spine and then through the triangular fascia and unites it to the internal oblique aponeurosis. The suture is then continued upward approximating the internal oblique and the transversalis fascia to Poupart's ligament. Each stitch includes the transversalis fascia. As shown in the insert interrupted silk sutures are placed in the gaps between the fascial loops and are used to unite the adjacent edges of the loops. Completed this forms a continuous band of fascia from the pubic spine to the internal ring.

surface of the internal oblique fascia with two encircling and transfixing sutures of silk. Between the fascial loops are placed interrupted sutures of silk to relieve tension and to insure intimate approximation of the layers. The fascial loops are then unfolded and the adjacent edges brought together with interrupted silk sutures to close the gaps and form a solid band of fascia. Silk is used in preference to catgut because it incites less tissue reaction and probably gives stitch service for a longer period of time.

With one or two sutures of silk or chronic catgut Poupart's ligament and the internal oblique muscle are approximated above the cord. These sutures are so placed that the new formed ring fits snugly around the cord.

The edges of the external oblique fascia are then approximated under the cord with interrupted silk sutures. This is usually possible despite the loss of the strip used for a suture. If however this cannot be done without tension a second narrower strip is cut from one of the flaps and used as a pedicled suture to lace the edges of

the flaps, or the superior one is brought down as far as possible and sutured to the internal oblique fascia. Above the cord the edges can always be approximated. The superficial fascia is reunited over the cord and the skin is closed with interrupted sutures.

This technique is applicable in all but a few cases. Occasionally, the aponeurosis of the external oblique is inadequate or unsuitable for use as sutures. This difficulty may be encountered in recurrent hernias. Under such circumstances strips of fascia lata can be substituted. Again, there are those direct hernias in which the internal oblique aponeurosis is either wanting or inserts into the rectus sheath at some distance above the pubic spine. In these cases the inguinal triangle is very broad and there is need of more fascia for support than can be supplied by strips of the external oblique aponeurosis. Since hernias of this type are often asymptomatic, are unlikely to strangulate, usually occur in older, less active individuals, and recur in such a high percentage of instances following operative repair, Andrews has questioned the advisability of treating them surgically. Certainly, if repair is undertaken, such autoplasmic operations as those of Gallie, Halsted, Bloodgood, Andrews, and Wangenstein are indicated. Recently, I have used an operation which will be described in a subsequent publication.

In children, recurrences after the classical operations are rare and autoplasmic operations of any type are unnecessary. This has been emphasized by Hoguet in his statement that in 827 consecutive and personally executed operations for inguinal hernias in children not a single recurrence had developed up to the time of his report.

The use of strips of the external oblique aponeurosis for fascial sutures has certain advantages. The entire operation can be carried out within a single wound not significantly larger than that necessary for any other type of repair. Consequently, the chances of a break in asepsis with infection is minimized. At the distal end the normal attachment of the fascial strip is preserved, thereby a secure anchorage and some blood supply is maintained. For this reason there is less chance of the suture slipping and some questionable vascular aid to survival of the fascia. Finally, the fashioning and placing of the suture requires very little time and inflicts little or no additional trauma to the patient.

The operation strongly fortifies the entire inguinal triangle. This is an important detail in all hernias including even the simple indirect types which, when they recur, recur not infre-

quently in the form of direct hernias. Thus, indirect hernias should be considered potential direct hernias and the repair planned accordingly.

#### THE RATIONALE OF THE ROUTINE USE OF LIVING SUTURES OF FASCIA

In published and unpublished reports dealing with the operative repair of hernias two facts stand out: (1) most analyses of large series of cases, which have had adequate tests of time, reveal recurrences in excess of 10 per cent in direct hernias and 7 per cent in indirect hernias, and (2) from impressions and from such follow-up observations as are available there has evolved the opinion among several surgeons that living sutures of fascia contribute much to the security of repair and should be used for recurrent and other hernias uncertain or impossible to retain by other means. If fascial sutures give added security and are indicated for repair of these more difficult types of hernias, it logically follows that the more routinely used for the repair of simpler hernias the fewer will be the recurrences. Concurring in this opinion, as expressed by Gallie, I have used routinely the autoplasmic operation here described for all inguinal hernias in adults with the exception of the grossly deficient type of direct hernia discussed previously. Inasmuch as the use of sutures of external oblique fascia does not appreciably increase the duration or trauma of operation or the likelihood of infection, there appears to be no particular contraindication to their use routinely. But why should an operation of this type be used routinely for simple indirect hernias?

Unquestionably, many indirect hernias are cured when the sac is disposed of and the usual subsequent repair is superfluous. Again, most of them and some of the direct hernias are retained adequately by the support of the Ferguson or Bassini types of repair. However, the mere fact that statistics show that recurrences do develop in an astonishingly large number of indirect as well as direct hernias and occur in the hands of the most competent surgeons and in the presence of circumstances which are considered favorable to cure, indicates the need of technical improvement in the operations themselves or their applications. As stated previously, indirect hernias recur not infrequently as direct hernias so that an adequate repair should preclude this possibility as well as cure the primary indirect hernias.

Some recurrence records from representative American and European clinics are presented in Table I with the names of the surgeons who made the report.

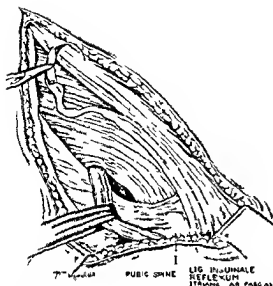


Fig. 1 Illustrated are certain essential technical details. The anterior and inferior surfaces of the pubic spine are exposed in order to develop the triangular fascia and to permit freeing of the strip of external oblique aponeurosis to a level below the triangular fascia. The line of incision is indicated by the broken line. The free end of the suture has been fastened to the author's needle which is described in an article now in press (2). The stump of the hernial sac and the tissues to the floor of the canal were blacked out in the drawing to emphasize the borders of the inguinal triangle.

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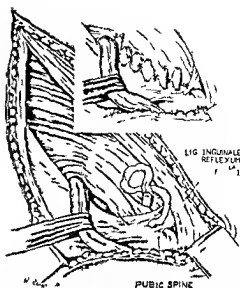


Fig. 2 The fascial suture first seals the superpubic area by passing over the pubic spine and then through the triangular fascia and unites it to the internal oblique aponeurosis. The suture is then continued upward approximating the internal oblique and the transversalis fascia to Poupart's ligament. Each stitch includes the transversalis fascia. As shown in the insert interrupted silk sutures are placed in the gaps between the fascial loops and are used to unite the adjacent edges of the loops. Completed this forms a continuous band of fascia from the pubic spine to the internal ring.

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- 9 ERDMAN, S Inguinal hernia in the male Ann Surg, 1923, 77 171
- 10 FALLIS, L S Inguinal hernia A report of 1600 operations Ann Surg, 1936, 104 403
- 11 GALLIE, W E, and LEMESURIER, A B The use of living sutures in operative surgery Canadian M Ass J, 1921, 11 504
- 12 Idem The transplantation of fibrous tissue in the repair of anatomical defects Brit J Surg, 1924, 12 289
- 13 HALSTED, W S The cure of the more difficult as well as the simpler inguinal ruptures Johns Hopkins Hosp Bull, 1903, 14 208
- 14 HOGUET, J P Observations on 2468 hernia operations by 1 operator Surg, Gynec & Obst, 1923, 37 71
- 15 LAMERIS, H J Zur Behandlung der indirekten Leistenhernie Deutsche Ztschr f Chir, 1912, 119 569
- 16 LYLE, H H M Fascial sutures for inguinal hernia Ann Surg, 1928, 88 870
17. MCARTHUR, L I Autoplastic suture in hernia, and diastases J Am M Ass, 1901, 37 1162
- 18 NEIDLICH, V Erfahrungen und Resultate bei Operierten Leistenhernien Deutsche Ztschr f Chir, 1921, 165 34
- 19 TAYLOR, A S The results of operations for inguinal hernia Arch Surg, 1920, 1 382
- 20 WANGENSTEEN, O H Repair of recurrent and difficult hernias and other large defects of the abdominal wall employing iliotibial tract of fascia lata as pedicled flap Surg, Gynec & Obst, 1934, 59 766.

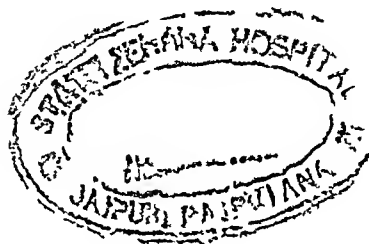


TABLE I

Auth	Date	Number of cases		Percentage recurrence			
		Indirect	Direct	Indirect or direct suture	Fascia sutures	Direct suture or ligament	Fascia sutures
Fall's	1937	646	254	7.4	0	21.6	0
Andrews and Bissell	1933		48			27	0
Burrows	1931		28			23	
Blake						5	
Fridm	1923	665	363	3.0		0.64	
Higgin	1923	963	240	1.6		0.8	
Lamen	1912	311	204	3.9		5.4	
Druen	1919	503	371	5.0		15	
Neel	1921		272			23	
Taylor	1920	123	256	5.63		10.5	
Lytle	1928	301	275	0.0	5	14	0
Castell and Anderson	1931	123	55		4.6		7.8
Burdick, Gillespie and Higinbotham	1937	22	350		17.1		5.8

Many hernias listed above as direct hernias were combined direct and indirect hernias

These statistics present a low percentage of recurrence when fascial sutures were used. However, included in the table are too few reports of the results from the use of fascial sutures to give a proper comparative evaluation of the method. However, with the exception of the Burdick, Gillespie, and Higinbotham series the recurrence rates in general are definitely lower than are those resulting from other methods of repair. This difference is well shown by the direct comparison in Lytle's series and it becomes more significant in view of the statement made by all three authors including Burdick and associates that the cases in which fascial suture were used were principally the more difficult ones.

Fascia has certain qualities which make it a superior suture material. These have been pointed out by Gallie. He has shown that fascia incites no inflammatory reaction, survives for years if not indefinitely, unites with the tissues in which it is imbedded, has great tensile strength and does not stretch under pressure as does scar tissue. This is an important difference because the support from the classical type of repair is as strong as the scar which unites the aponeuroses so that the tendency of scar tissue to stretch and give way under pressure is probably a responsible factor in recurrences. It has been my experience, however, to find Poupert's and the conjoined tendons widely separated and presenting surprisingly little scar or evidence of a previous fusion.

## SUMMARY

1. An autoplasmic technique for the repair of inguinal hernias is reported. This technique is original only in so far as it combines certain established principles. It has the advantage of the security obtained from the use of living sutures of fascia without increasing perceptibly the duration and trauma of operation. It utilizes the triangular ligament to solidify the repair by closing the vulnerable area immediately above the pubic spine.

2. The logic for adopting the routine use of autoplasmic repair of inguinal hernias in adults is stated.

## BIBLIOGRAPHY

1. ANDREWS F. and BISSALL V. D. Direct hernias: a record of failures. *Surg. Gynec. & Obst.* 1934 58: 753.
2. BIGGARD J. D. Anatraumatic needle. *Am. J. Surg.* In press.
3. BLAIR. Quoted by Andrews and Bissell.
4. BLOODGOOD J. C. The transplantation of the rectus muscle or its sheath for the cure of inguinal hernia when the conjoined tendon is obliterated. *Ann. Surg.* 1919 70: 87.
5. BURDICK C. G., GILLESPIE D. H. M. and HIGINBOTHAM L. Fascial suture operations for hernia. *Ann. Surg.* 1937 706: 333.
6. BURROWS H. J. A note on direct inguinal hernia. *St. Bartholomew's Hosp. Rep.* 1931 64: 195.
7. CASTELL R. B. and ANDERSON C. End results in the operative treatment of inguinal hernia. *New England J. Med.* 1931 203: 430.
8. DRUCKER O. Die Operation der Leistenhernie. *Deutsche Zeitschr. f. Chir.* 1920 150.

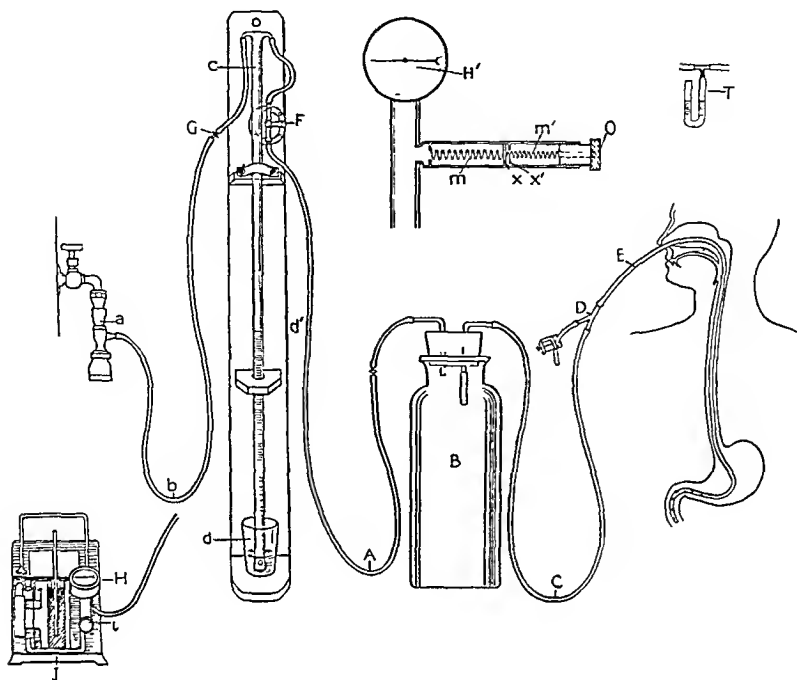


Fig 1 Two sources of power, two methods of measuring the negative pressure, and one of regulating the vacuum are portrayed. These can be hooked up in several combinations. Water pump, *a*, is connected to water manometer, and this to bottle. The suction is regulated by valve, *F*, detail of which is seen in upper middle part of illustration. Electric pump can be substituted for water pump with the control valve an integral part of it. Instead of the water manometer, the mercury one, *T*, can be connected between the pump (either water or electric) and connecting bottle.<sup>1</sup>

The method is simple, needs only a minimum of attention, takes up very little space, and is highly efficient. As an illustration of the dependability of the electric pump on a suprapubic bladder drainage case, it was run for 9 weeks,

<sup>1</sup>Since this illustration was made the American Cystoscope Makers have produced a pump in which the regulating valve and an adjustable mercury manometer are incorporated as integral parts.

practically continuously, with no other attention than oiling the motor every other day. The run was terminated when the patient left the hospital, and there was no indication that it could not have been continued for an indefinite period. In intestinal suction drainage cases it has been run for 3 to 5 days and stopped only because there was no further need for it.

# MODIFIED WANGENSTEEN SUCTION DRAINAGE

H DAWSON FURNESS M D F A C S , New York, New York.

THE Wangensteen method of suction drainage has proved itself of great value in intestinal obstruction of the non-strangulated type. The method, here described, is I believe a simplification of the original being the same in all particulars except the production of suction.

Suction can be obtained by either a water aspirator or by an electrically driven pump. My experience has been with the motor driven pump designed by Dr. Stedman for suprapubic bladder drainage. The motor (eddy current) operates on 110 volts and 60 cycles. It is small, almost noiseless, can be run indefinitely with no other attention than being oiled every 2 days, does not over heat, and is not harmed by being stalled. It is efficient up to 15 inches mercury negative pressure. In connection with the pump, the makers have designed for me a valve to regulate the vacuum. A manometer of the water or mercury type is used to determine the vacuum.

The details of the valve are shown in the upper middle part of the illustration. At the mid-portion of a tube is an annular perforated flange,  $x'$ , on which seats a movable disc valve,  $x$ . Attached to either side of this valve are springs the stronger,  $m$  being on the pump side, and the weaker  $m'$  on the intake side. At  $o$  there is a perforated plug threaded into the tube. Screwing this plug inward compresses the spring  $m'$  thus lessening the forces exerted by the stronger spring,  $m$ . Decreasing the tension upon it has the reverse effect. It can be so adjusted that the disc will be unseated by negative pressure greater than zero and less than 10 inches (mercury).

For the low pressures used in the Wangensteen method the ordinary gauge is not sufficiently delicate or accurate and therefore a water manometer was constructed along the lines devised by Dr. Donald Gordon. It consists of a tube, 1 inch in diameter with a small opening just above the lower end and a T outlet at the top, one branch of which is connected to the source of suction and the other to the shorter tube of a two tube stoppered collecting bottle. The lower end of the manometer is placed in a glass of water and the position of the small opening so adjusted that the desired vacuum can be obtained. When suction is applied and the stomach end of the tube is obstructed a vacuum is

produced in the bottle and in the manometer thus drawing the column of fluid up into the tube. When the water level in the glass reaches that of the small opening air is drawn into the tube and thus the production of a vacuum greater than that measured by the height of the water column is prevented. With the small opening near the bottom and the large caliber of the tube, the air enters in bubbles, and does not blow the water out of the tube as would happen with a small caliber tube. Without a regulatory apparatus on the pump this action is too turbulent.

The valve, which is on the electric motor or on the frame work of the water instrument, is so adjusted that it allows air leakage into the system in just the amount to obtain the desired vacuum.

In practice, it is well to adjust the instrument so that when the desired vacuum is obtained, the water level in the tumbler is just above the small opening in the tube. Should, by chance anything happen to the valve that would impair its action and the vacuum be raised, air would be sucked through the small hole and the manometer act as a safety protection.

A U shaped mercury manometer can be substituted for the water instrument by connecting it with a T tube, one arm to the pump (either water or motor) and the other to the collecting bottle. The only advantage it has over the water instrument is its compactness, a disadvantage is that it is not so accurately adjustable, as 1 inch of mercury is the equivalent of 13.6 inches of water.

Gastric and duodenal suction drainage is best carried on at a negative pressure of 24 to 30 inches of water at the intestinal end of the tube. The pump vacuum should be so adjusted that it, combined with the negative pressure produced by the column of fluid between the stomach and bottle, equals the desired operating value. For example if one is to work with a suction of 24 inches and the bottle end of the tube is 12 inches lower than the intestinal end the apparatus should be so adjusted that the manometer will read 12 inches.

When the water aspirator is used the faucet is so adjusted that the desired vacuum is obtained with the least water flow. The valve at  $f$  and the manometer will keep the instrument at the proper level.

can also be prevented by proper pre-operative care, namely absolute abstinence from water or food by mouth. Parenteral administration of fluids must be insisted upon. In practically every case, even if gangrene is present, the acute symptoms will abate in 24 or 48 hours under this regimen.

A much better and more logical operation in reference to anatomical lines can be performed if the symptoms are allowed to subside. An incomplete operation or one performed in two stages should be avoided because those who have had the stage operations have a more serious convalescence than those who have been operated upon in one stage after subsidence of symptoms.

The morbidity and mortality will be greatly increased if the dictum shall prevail that all acute inflammations of the gall bladder should be operated upon at once. More accidents pursuant to the operation will result when they are performed in the acute stage and the mortality will be correspondingly higher.

MOSES BEHREND

## THE USE OF DRUGS IN SURGERY

**I**N early periods of development of surgical therapy standardized procedures often were advocated for given diseases, without consideration of individual variations. Thus many surgeons performed gastro-enterostomies on all peptic ulcers. Routines were followed in the management of toxic goiters without regard for the degree of toxicity or the individual responses of the patients. Experience and a better knowledge of the fundamentals of diseases and their treatment have taught that best results can be obtained only when each patient is studied individually and treated by the method best suited to his problem. Certain routines, however, are still

followed without taking into account the variations in response, and often without an adequate knowledge of their physiological and pathological effects. This is particularly true of the use of drugs in surgery. Many surgeons have standard pre-operative and postoperative orders for all operations, regardless of the nature of the procedure or individual characteristics of the patient.

Disturbances of intestinal motility such as postoperative nausea, vomiting, distention, gas pains, and ileus constitute a high incidence of surgical morbidity. Patients frequently manifest a greater fear of these complications than of the operation. To combat them a variety of drugs is advocated both for prophylactic and therapeutic use. Claims of high efficiency are made for a number of agents if administered repeatedly before and after operation. Such preparations are often used without a thorough understanding of their action. The difficulty of securing human preparations suitable for accurate study is largely responsible for this confusion.

Many surgeons still hold the opinion that morphine "splints the bowel" although physiologists for years have shown that this drug increases small bowel peristalsis. Recent studies have confirmed this action of the opiates, but have shown that they inhibit motility of the right colon, thus explaining their constipating action.

Other drugs, such as eserine, prostigmin, mecholyl and acetylcholine, also have been shown to increase small bowel motility and inhibit colon contractions. Derivatives of the pituitary gland, pituitrin and pitressin have the opposite effect, diminishing small bowel motility but vigorously contracting the colon. Atropine has an inhibiting effect on the entire bowel and when used with morphine will counteract the stimulating action of the latter drug on the small intestine.



# EDITORIALS

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## SURGERY Gynecology and Obstetrics

FRANKLIN H. MARTIN  
Founder and Managing Editor  
1905-1935

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LOYAL DAVIS, EDITOR

*Associates*

SUMNER L. KOCH                      MICHAEL L. MASON

DONALD C. BALFOUR *Associate Editorial Staff*

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JANUARY 1939

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### EDITOR APPOINTED

THE Board of Directors of the Surgical Publishing Company of Chicago have pleasure in announcing the appointment of Dr. Loyal Davis as editor of SURGERY, GYNECOLOGY AND OBSTETRICS, to fill the post made vacant by the untimely death of Dr. Allen B. Kanavel. Dr. Davis, who is professor of surgery and chairman of that department at Northwestern University Medical School, was appointed assistant editor of this journal in 1927 and associate editor in 1933. Under his able supervision the directors expect that the journal's high standard of excellence achieved in past years will be maintained.

### ACUTE INFLAMMATION OF THE GALL BLADDER. A PLEA FOR CONSERVATIVE OPERATION

DOUBTS that have lately arisen as to whether "immediate," "early" or "delayed" operations give the best results in the treatment of acute inflammatory

conditions of the gall bladder seem to have created a controversy not unlike the discussion that arose years ago concerning the superiority of cholecystectomy over cholecystostomy. Some misunderstanding has arisen as a result of the manner in which the designation of the time of operation has been made. "Emergency" should signify an immediate operation performed within an hour or two after the admission of the patient. The terms "early" and "delayed" are rather indefinite, they may mean any time after the patient has been admitted to the hospital. The term "opportune time," however, seems to me to be the best designation for the proper time to operate on acute cholecystitis or acute empyema of the gall bladder. The opportune time may mean that the operation may be performed immediately upon the admission of the patient or any time thereafter, as the exigency of the case may present itself to the surgeon.

The proponents of the emergency operation fear perforation. Perforation of the gall bladder as a matter of fact is a rare occurrence. In a period extending over 25 years I have had the experience of operating upon one acute perforation of the gall bladder. Pathological anastomoses of the gall bladder with other viscera must be considered perforations but these are not to be confused with the acute types. Perforations of the gall bladder can be prevented if the physician who sees the patient in the first attack of colic would promptly seek the advice of a surgeon. During an attack of acute empyema the patient should be hospitalized immediately and placed under the care of the surgeon. Perforations accompanying acute empyema of the gall bladder



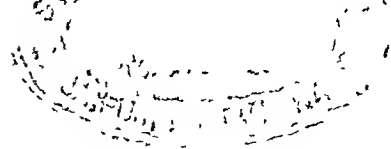
This understanding of the action of drugs enables us to use them more intelligently on our surgical patients. Morphine or other opiates are used to allay pain almost universally before and during the first 24 to 48 hours after surgery. As they increase small bowel peristalsis but inhibit colon contractions, the patient will have bowel contents accumulating in the right colon, where it will remain and liberate gas with resultant distention and gas pains. It seems logical therefore, that these symptoms can be avoided or relieved by evacuating the colon with enemas, augmented if necessary by a pituitary extract. Gas rarely accumulates and distends the small bowel except in cases in which intestinal obstruction or ileus exists. Most gas pains are due to pressure within the colon. Nausea and vomiting following large doses of opiates may be due to a marked small bowel stimulation with reverse peristalsis resulting. When such symptoms occur these drugs should be discontinued or combined

with such agents as atropine or hyoscine to counteract intestinal stimulation. Following surgery on the stomach and small bowel if we suspect atony from trauma and manipulation, we may encourage peristalsis by the use of opiates, prostigmine, or other stimulating drugs.

These likewise might be of value in ileus. We must, however, remember their inhibiting action on the colon. Most postoperative abdominal distention is due to gas in the colon. Here pituitrin or pitressin combined with enemas serve very well to relieve the distress by emptying the large bowel. It is inadvisable to use them repeatedly every few hours except when specially indicated, because of the paralytic effect on the small bowel.

With an understanding of the action of the various drugs employed we can use them more judiciously, and should be able to offer our patients a more comfortable convalescence.

CHARLES B. PUESTOW



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SIR DAVID WILKIE

1862 1938

# MEMOIRS

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## SIR DAVID WILKIE

THE recent sad death of Sir David Wilkie at the height of his fame and career has been a great loss not only to British surgery but to the whole civilized world for, since medicine differs from most other professions in being international in its scope, he belonged not to Great Britain alone. Wherever there is modern surgery, there will he be mourned.

Born in Kirriemuir, Angus, in 1882, Sir David was educated at the Edinburgh Academy and the Edinburgh University. In 1904 he graduated M.B., Ch.B., and took his higher university degrees of M.D., in 1908 and Ch.M., in 1909. He took the fellowship of the Royal College of Surgeons of Edinburgh in 1907 and that of the Royal College of Surgeons of England in 1918.

After graduation he filled resident posts in Edinburgh, and then studied abroad in Bonn, Berne, and Vienna. In 1914 he was appointed surgeon to the Leith General Hospital, and assistant surgeon to the Royal Infirmary, Edinburgh. During the War he served as surgeon-commander to the Royal Naval Volunteer Reserve. In 1924 he was appointed to the University chair of surgery.

In this period his publications, which were mainly devoted to abdominal surgery, and his powers as a teacher and lecturer were firmly establishing his reputation, not only in his native town of Edinburgh, but throughout the surgical world. In 1929 he was selected by the American College of Surgeons to give the Murphy Oration in Surgery, having been awarded the much prized honorary fellowship of that College in 1926. In the same year he was appointed corresponding member of the French Academy of Surgery and given the fellowship of the Royal Society of Edinburgh. In 1936 he was rewarded with a knighthood and in the same year was made president of the Association of Surgeons of Great Britain and Ireland.

So bare a statement of his record and progress gives, however, no real description of the man. All who knew him admired and respected him. It is, alas, only too often that those who have attained success and fame in their profession are subjected to scathing and spiteful criticism but, although some must have envied him his many gifts, I have never heard, in the many years I have known Wilkie, any unfair censure of his work, or any word other than praise of his character and ability.

His skill and popularity as a teacher are naturally best known to his own students in Edinburgh, but it is characteristic of him that he had the wider outlook, and since his appointment as professor of surgery continued untiringly

to create a department of surgical research, a department which grew in size and reputation until it was known throughout the world and until no surgeon visiting Britain felt that his trip was complete until he had visited Sir David Wilkie. He made Edinburgh a surgical mecca to surgeons in America, England, and the British colonies, while many from other countries have benefited from his skill as a teacher, and what is of much greater value, from his personal magnetism, encouragement and guidance.

In his surgical work his most striking characteristic was the clearness and lucidity of his thought. I have attended very many surgical meetings with Wilkie and have heard him speak. He usually made his remarks late in the meeting, and one was always struck with his ability to pick out the really salient points, to direct attention to the matters of doubt, and to sum up the situation in a few masterly words. Whatever he said and upon whatever subject he addressed the meeting one felt that when he had finished the last word had been said and always his remarks were followed by a round of applause which came spontaneously from surgeons from all parts of the world. It was real and well earned admiration and not the loyalty of local admirers. Whenever he spoke it was manifest that we had the privilege of listening to a real leader of the profession. So greatly was his surgical ability recognized that more and more demands were made upon his time, but his services were always willingly and ungrudgingly given.

He served on the Army Medical Advisory Board, on the Scientific Advisory Committee of the British Empire Cancer Campaign, on the Scottish Board of Health, and on the Medical Research Council. He was also chairman of the Committee of the Ministry of Mines.

Apart from his powers of teaching and of debate he gained fame as a surgeon by his many contributions to surgical literature, each one of which was a master piece of lucidity and contained some new point in the advancement of his craft. The value of his original work was recognized in 1918 when he was awarded the Liston Victoria Jubilee Prize of the Royal College of Surgeons of Edinburgh.

These outstanding abilities of surgery, however, illustrate only one side of his character. His wide activities in the social structure of his native town, in which he was so ably encouraged and assisted by Lady Wilkie, made him beloved by all in Edinburgh. For many years he was chairman of the University Settlement which supervised housing schemes and courses of instruction in general educational subjects and in vocational training. In 1933 he purchased an old cinema, reconstructed it and presented it anonymously to the Settlement as an educational and vocational institute for working class people. There must be many in Edinburgh who feel that they owe him what progress they have made in life. His addresses on many general subjects were much appreciated by large audiences.

It was always a matter of astonishment to his friends that one who had suffered in health should be able to accomplish so much in so many branches of life, and never show any signs of weariness. Any one of the above gifts would have brought a man respect, honor, and admiration, but to those who knew him there was an even greater characteristic, and that was his personal courage. A short time ago all were distressed to hear of his serious illness; from this he recovered and in a short time was back at full work. There was never any suggestion of limiting his activities. He still traveled over long distances to his various meetings and was always cheerful and active. When a short time ago he found he was suffering from a serious disease he faced it with great fortitude and up to the time of his operation discussed general problems impersonally and enthusiastically. Nearly twenty-five centuries ago Euripides said "Take the chance of dying nobly while yet you may lest in a short time death indeed come to thee but a noble death no more." Those who knew of Wilkie's end realize that here was a man who set a fine example of how to die nobly. A great and noble character has left us but there are very many in whose hearts he will live forever.

JAMES WALTON.



## REVIEWS OF NEW BOOKS

THE Editor wishes to correct the last paragraph of the review of Dr. Cushman's *Meningeal* on 171 which appeared in the December 1918 issue page 834 to read:

Written in a charming style the material and statistics arranged in an interesting manner by Dr Eisenhardt the reader does not need to be a neurological surgeon to follow the story with profit to his surgical soul.

THE textbook entitled *Massage and Remedial Exercises* can be recommended as a textbook on massage and exercise for physical therapy technicians. Under each subject the author gives a digest of the pathology and symptoms and the medical or surgical treatment. The physical treatment by massage movements and exercise is considered in detail. The illustrations are excellent. The print is small. The volume contains a mass of information. The book should be useful to the general practitioner too as it gives information on the use of massage and exercise. J. S. COLLIER

THE morphology of arteriosclerosis with emphasis upon the vascularity of the vessel wall and its relation to the disease manifestations of the intima is presented by Wintermuth Thomas and LeCompte in their recent book.\* By various processes of clearing the walls and injection of the blood channel the vessel walls as well as changes in the walls themselves become apparent. As expressed by the authors this material is presented with the hope that the prevalent conception of arteriosclerosis as a degenerative process will be replaced by an understanding of the vessel wall as similar to any other organ of the body in that it may be the seat of acute exudations, hemorrhage or proliferative reactions which may undergo a whole series of morbid alterations. The observation that the most vascular areas of the vessel wall are those adjacent to the origin of branches that intramural hemorrhage occurs most frequently in the areas and also that these same areas are the most frequent site of arteriosclerotic processes stimulated the desire to investigate a possible causal relationship. Studies were made of the embryological development of blood vessels in order to determine the source of the new vessels which occur in disease processes. The vascularity of ves-

sel in health and disease as well as the differences in various age groups was demonstrated and contrasted with that in several species of animals. The pathological changes in the heart valves in endocarditis were found to be strikingly similar to the arteriosclerotic process in the vessels and the question was raised as to a common etiology. The anastomotic connections between the various vasa vasorum and the ability of the vasa to increase in size make possible the maintenance of blood flow through the mural channels when the lumen of the blood vessel is occluded or narrowed.

It is obvious that an immense amount of careful work preceded the publication of this book. It is concise and well expressed. Each point brought out is illustrated from various angles. Most of the illustrations which consist of drawings as well as photomicrographs are in color and are truly remarkable. The concept of the blood as an organ richly supplied throughout with blood vessels of its own opens a new vista in the study of vascular disease.

Not only is the concept of vascular disease greatly advanced by this splendid piece of work but the authors and publishers are to be commended for the beautiful presentation of the material.

## VI. НРАВСТВЕНА ВАРКА

**I**N this country McPheeters<sup>1</sup> is a pioneer in the injection treatment of varicose veins and his monograph on the subject has proved a practical guide for those who are interested in this type of therapy. Almost a decade has elapsed since his book first appeared during which time a vast amount of work has been done in response to the stimulus offered by the injection treatment. The most significant developments have been the search for better sclerosing agents and increased emphasis upon the hydrodynamic problems involved in varicose veins. The latter has resulted in insistence upon high saphenous ligation as a preliminary to injection in selected types of cases. McPheeters has kept abreast of these changes in his new monograph. Like most of the other workers in this country he has adopted solutions of salts of the fatty acids as the preferred sclerosing media. A chapter on preliminary ligation of the saphenous vein has been included. In addition there is a discussion of the causes of failure following injection, the principal ones according to the author being inaccurate diagnosis, incorrect technique, and failure to ligate when ligation is indicated. The chapter on the treatment of varicose ulcers has been rewritten with amplification of the author's

INJECT & TREATMENT OF VARIOUS LEYS AND HEMORRHOID By  
H O McPhee in MD FACS a d Jans b r And man MD  
FAC & Ph d l l o s F A Days Co 1984

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1917. **THE BIOLOGY OF ARTER SCLEROSIS.** By W. C. Wadsworth, M.D.  
R. M. Thomas, M.D. and F. M. LeCompte, M.D. Springfield, Ill. and  
Baltimore, Md. Charles C. Thomas, 914

method of sponge compression. Included in the present volume is a brief, straightforward discussion of the injection treatment of hemorrhoids by James K. Anderson. The injection treatment of varicose veins is here to stay, and McPheeters' monograph will continue to serve as a practical guide to those interested in the method. LEO M. ZIMMERMAN

THE volume of 300 pages by Albert Edward Schlanser<sup>1</sup> is a short, concise manual on diseases of the ear, nose, and throat intended for use in the regular army and is based on many years of experience and observation in peace time. The work is essentially clinical and consequently detailed symptomatology, anatomy, and physiology are purposely omitted.

The book is composed of six chapters dealing chiefly with the patient's complaints followed by a short dissertation on diagnosis and treatment. There are 81 illustrations.

Obviously, it is impossible to condense into 300 pages all the work in otolaryngology but it will enable one to handle confidently and expeditiously each of the many complaints occurring in routine army practice. The student and civil practitioner would find it of doubtful value. JOHN F. DELPH

THE seventeenth volume of a series of research publications of the Association for Research in Nervous and Mental Disease<sup>2</sup> is made up of the proceedings of the meeting of the Association held in New York on December 28 and 29, 1936.

Like the preceding volumes of this series, this book presents an imposing list of contributors, all of them men in the first rank of American anatomists and neurologists. Five chapters on the anatomy of the pituitary gland, 22 chapters on its physiology, and 15 chapters on general considerations of clinical importance, indicate the comprehensive scope of this work, and it embodies a complete summary of the significant recent advances in our understanding of the hypophysis and its relation to the rest of the organism.

The introductory chapter, by Frederick Tilney, on the various glandular components of the brain, is indeed classical in its treatment. Not only does it present the origin and functional meaning of the various "roof" and "floor" glands, but the origin

and nature of the individual hypophyseal components down through the various phyla are described with a clarity and simplicity difficult in the handling of such a subject. A short chapter by Oscar Riddle on "prolactin" will no doubt serve to dispel certain existing false concepts of this hormone, and he has indicated the apparent potential clinical usefulness of this substance. Wayne J. Atwell, in a discussion of the enigmatic pars tuberalis, is unable to assign any physiological function to this portion of the hypophysis, though morphological studies indicate some presumptive evidence of function. The chapter on pituitary basophilism by Irving Pardee, together with the section on pituitary cytology by A. E. Severinghaus, adds much valuable data concerning this interesting disease entity, in which there has been, since 1932, an ever widening field of anatomical and clinical research. There is a concise but complete discussion of acromegaly by Tracy J. Putnam and Leo M. Davidoff.

The material in this book is well balanced, and almost all of it is of direct practical value. It should do much toward the stabilization and correlation of the constantly increasing maze of information relative to the endocrine system. JOHN MARTIN

THE popularity of *Electrotherapy and Light Therapy*<sup>3</sup> by Kovács is demonstrated by the demand for a third edition within 5 years of its original appearance. The new edition has been thoroughly revised and much new material has been included to bring down to date the knowledge concerning this field. In general the illustrations are well selected, but the many illustrations of various machines could well be replaced by further illustrations of technique.

The book presents the physics, the apparatus, the physiological effects, the indications and contraindications for electrotherapy. The chapters on electrophysics, galvanic current, and electrosurgery have been revised. There have been added new chapters on the relation of electrophysiology to electrotherapy, on short wave diathermy, and on artificial fever by electrical means.

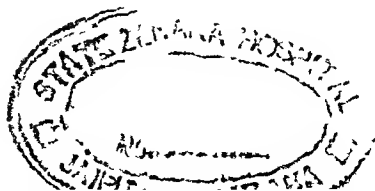
The physics of radiant energy, the physiological effects of the various forms of infrared, visible and ultraviolet radiation, and their clinical applications are also presented. The volume is orderly in arrangement, concise, and sound. It can be recommended to physicians as the best textbook on these subjects.

J. S. COULTER

<sup>1</sup>PRACTICAL OTOTOLOGY, RHINOLOGY AND LARYNGOLOGY. By Albert Edward Schlanser, M.D. Philadelphia: Lea & Febiger, 1938.

<sup>2</sup>THE PITUITARY GLAND, AN INVESTIGATION OF THE MOST RECENT ADVANCES. Vol. 17 of a Series of Research Publications by the Association for Research in Nervous and Mental Disease. Baltimore: The Williams & Wilkins Co., 1938.

<sup>3</sup>ELECTROTHERAPY AND LIGHT THERAPY. By Richard Kovács, M.D. 3d ed. Philadelphia: Lea & Febiger, 1938.



## BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

**CANCER ITS DIAGNOSIS AND TREATMENT** By Max Cutler M.D. and Franz Buschke M.D. Assisted by Simeon T. Cantril M.D. Philadelphia and London W. B. Saunders Co. 1938

**SPINAL ANESTHESIA** By Louis H. Mayson A.B. Foreword by W. Wayne Babcock M.D. LL.D. F.A.C.S. Philadelphia London New York Montreal J. B. Lippincott Co., 1938

**PHYSICAL DIAGNOSIS** By Richard C. Cabot M.D. and F. Denette Adams M.D. 11th ed. Baltimore: William Wood & Co. 1938

**THE SURGERY OF ORAL AND FACIAL DISEASES AND MALFORMATIONS. THEIR DIAGNOSIS AND TREATMENT INCLUDING PLASTIC SURGICAL RECONSTRUCTION** By George Van Ingen Brown D.D.S. M.D. C.M. F.A.C.S. 4th rev. ed. Philadelphia: Lea & Febiger 1938

**PHYSIOLOGY OF THE NERVOUS SYSTEM** By J. F. Fulton M.A. D.Ph. (Oxon.) S.B. M.D. London: New York Toronto: Oxford University Press 1938

**MARIHUANA: AMERICA'S NEW DRUG PROBLEM. A SOCIOLOGIC QUESTION WITH ITS BASIC EXPLANATION DEPENDENT ON BIOLOGIC AND MEDICAL PRINCIPLES** By Robert F. Walton. With a Foreword by E. M. K. Geising. Philadelphia: London: Montreal: Chicago and New York: J. B. Lippincott Co. 1938

**PRACTICAL BIRTH CONTROL METHODS** By Norman C. Humes J.D. with the medical collaboration of Abraham Stone M.D. Introduction by Robert L. Dickinson M.D.

Foreword by Havelock Ellis. New York: Modern Age Books 1938

**SOCIAL HYGIENIC NURSING TECHNIQUE. A MANUAL OF PROCEDURE IN THE DIAGNOSIS, TREATMENT AND PUBLIC HEALTH CONTROL OF SYPHILIS AND GONORRHEA** By Nadine B. Geitz M.A. R.N. New York: American Social Hygiene Ass. 1938

**CLINICAL LABORATORY METHODS AND DIAGNOSIS. A TEXTBOOK ON LABORATORY PROCEDURES WITH THEIR INTERPRETATION** By R. B. H. Gradowohl M.D. 2d ed. St. Louis: The C. V. Mosby Co. 1938

**THE FUNCTIONS OF HUMAN VOLUNTARY MUSCLES** By Norman D. Royle M.D. Ch.M. F.R.A.C.S. Sydney and London: Angus & Robertson Ltd. 1938

**CONTROL OF CONCEPTION** By Robert Latou Dickinson M.D. F.A.C.S. 2d ed. Medical Aspects of Human Fertility Series Issued by the National Committee on Maternal Health. Baltimore: The Williams & Wilkins Co. 1938

**CLASSIC DESCRIPTIONS OF DISEASE WITH BIOGRAPHICAL SKETCHES OF THE AUTHORS** By Ralph H. Major M.D. 2d ed. Springfield Ill. and Baltimore Md. Charles C. Thomas 1939

**ANATOMIA DE NEONATO** By Francesco Belli. Preface by Prof. Sen. Giunio Salvi. Naples: C. U. F. Mussolini. Sezione Editoriale 1938

**THE PHYSIOLOGY OF ANESTHESIA** By Henry K. Beecher A.B. A.M. M.D. London New York Toronto Oxford University Press 1938

**PATHOLOGISCHE PHYSIOLOGIE CHIRURGISCHEER ERKRANKUNGEN (Experimentelle Chirurgie)** First 3 editions edited by Franz Post 4th ed. Edited by F. K. Kessel T. Merke F. Meythaler 1937. — **VERDAUUNG ORGANE** Edited by Th. Naegeli. Berlin: Julius Springer 1938

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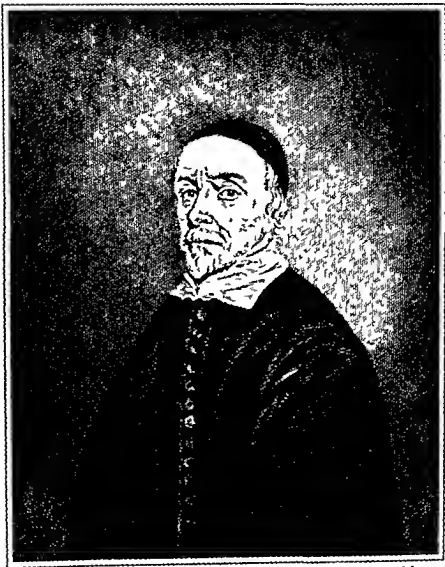


Fig. 10. 1657

*William Harvey*

1578 1657

# SURGERY

## GYNECOLOGY AND OBSTETRICS

*An International Magazine, Published Monthly*

VOLUME 68

FEBRUARY I, 1939

NUMBER 2

### ASEPTIC NECROSIS OF BONE

#### I Infarction of Bones in Caisson Disease Resulting in Encapsulated and Calcified Areas in Diaphyses and in Arthritis Deformans

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**C**AISSON disease is the result of injury to tissues by nitrogen bubbles liberated when the body, which in compressed air has absorbed an excess of nitrogen, is too rapidly removed from the decompression chamber. This explanation was first offered by Paul Bert in 1871 and it has been substantiated by the studies of Heller, Mager and Schrotter, Boycott, Damant and Haldane, Bornstein (6, 7), and others.

The amount of nitrogen absorbed varies with the duration and height of the pressure and with the different types of tissues. According to Bornstein, nitrogen saturation for a given pressure is not complete for 7 to 10 hours. Boycott, Damant, and Haldane estimated that there is practically complete saturation for man at high pressures in 5 hours. Bohr and Henriques showed that 100 cubic centimeters of shed blood absorbs at body temperature and one atmosphere pres-

sure 12 cubic centimeters of nitrogen and at 4 atmospheres 48 cubic centimeters. As to the different types of tissues, fat has been found to absorb the largest amount of nitrogen. Vernon reported that at body temperature and atmospheric pressure, fats (lard, olive oil, cod liver oil) dissolve more than five times as much nitrogen as an equal volume of water or blood plasma. He attributed the special tendency of the fat or lipid containing tissues, such as subcutaneous tissues, spinal cord and nerves, to suffer injury in caisson disease to this great solubility. Attention was called to the large amount of fat in the marrow of some bones but no mention was made of known lesions of the bones in caisson disease.

It has also been found (Bornstein) that the less active the circulation of a tissue the more slowly it absorbs nitrogen and in turn, the more slowly is the gas removed from it by the circulation when the increased pressure is reduced, consequently the greater the likelihood of gas bubble formation in it. The nitrogen has been found to damage the tissues most extensively by producing embolism but it also damages by the pressure of gas bubbles extravascularly.

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of the literature with a report of 4 cases involving the hip joint in one of which the lesion was bilateral. Symptoms were of relatively short duration, ranging from 4 to 18 months. All had worked from 3 to 4 years in compressed air. In all 4 cases the head of the femur roentgenologically showed scattered areas of reduced density, mixed usually with blurred areas of normal to slightly increased density. There was a variable amount of irregularity of the shadow of the articular cortex and slight flattening of the weight bearing surface of the head in each case. The cartilage space was little narrowed and the acetabulum little changed. Slight marginal lipping of the head was present in 3 cases. Christ concluded that nitrogen gas embolism had occurred in the vessels of the head of the femur producing subchondral necrosis of bone. This was followed by spotted absorption of the necrotic bone with irregularity and sinking in of the articular surface. He mentioned gas bubble formation in the bone but considered it unlikely despite the presence of fat in the medullary canal and the sluggish circulation of the bone marrow.

No case has been reported in the literature in which pathological examination has been made of the bone and joint changes except the grossly examined infected bone which was reported by Twynam.

#### CASE REPORTS

Four cases of caisson disease with extensive changes in the skeleton have been studied clinically and roentgenologically. One case came to autopsy and in another a biopsy was performed on the involved head of the femur. Extensive lesions were revealed in diaphyses and in epiphyses of certain bones with changes in the joints, all of which appeared to be the result of massive aseptic necrosis of bone secondary to interruption of its blood supply by the liberated nitrogen gas.

**CASE 1** Necrosis of epiphyses with secondary deforming arthritis and massive necrosis of shafts of long bones in caisson disease of 35 years' standing.

A 61 year old white male has been a member of the Veterans' Administration Facility, Bath, New York, intermittently since 1930. His chief complaint is pain and limitation of motion in the hips and to a less extent in the left shoulder and knees. He has also



Fig 1 Case 1 Deforming arthritis of both hips and loose body, a

had varicose veins of both legs for many years with swelling, pruritus, and repeated attacks of thrombophlebitis.

The complaint referable to the joints dates back to an attack of caisson disease in about 1901 when he worked on the construction of the Cleveland Water Works tunnel. He was incapacitated for 6 or 7 days due to the severe pains experienced in the arms, hips, and legs. He never completely recovered and by 1907 he limped, favoring the left leg. By 1917 he had adopted the use of a cane and by 1930 his hips were so troublesome that he gave up his trade, that of a gunsmith. He has had a chronic cough most of the time for 5 years and during the past 2 months it has been severe and productive. Roentgenograms of the chest taken at intervals since 1933 show no lung change until 1936, when an infiltrative process was revealed extending into the right upper lobe from the right hilum.

Past history reveals no joint disturbance whatsoever before the occurrence of the caisson disease. There is no history of other illnesses of consequence.

**Physical examination.** Patient is an obese elderly man in fair general condition. He walks with a marked limp favoring the left leg and with the aid of a cane. Regional examination is essentially negative aside from the chest, left shoulder, spine, and lower extremities. There is dullness and impaired breath sounds are present over the right upper lobe, especially posteriorly. There is a rather conspicuous atrophy of the muscles about the left shoulder. Elevation of the left arm is limited to about 90 degrees. There is a definite scoliosis of the dorsolumbar region with convexity to the right. There is practically no abduction of either hip and considerable limitation of both rotation and flexion of both hips. Motion in the knees and ankles is practically normal. There are varicosities and scars from old varicose vein operations in both legs. The lower left leg is slightly swollen. Reflexes are present in both upper and lower extremities.

**Laboratory findings.** Laboratory examinations reveal negative blood Wassermann and Kahn tests, blood calcium and phosphorus, normal, normal white count, red blood cells, 4,000,000. Urine shows albumin with occasional hyaline and granular casts.

Roentgenograms were made of the entire skeleton. The hips showed very extensive changes most marked on the left side (Fig 1). There is marked flattening of the femoral heads with a narrowing of



Acute symptoms of caisson disease appearing a few minutes to hours after too rapid exit from the chamber are referable most frequently to the spinal cord, internal ears, brain, subcutaneous tissues, and the limbs. The commonest complaints are severe pains especially in the abdomen ("bends") and in the extremities, ringing in the ears with or without impairment of hearing, hemorrhages in the skin and mucous membranes, bluish mottled discoloration and induration of the skin and subcutaneous tissues, and in some cases, paralysis in the extremities. Severe cases may cause cerebral or pulmonary embolic symptoms and death may be an early result. Prompt recompression usually ameliorates and sometimes completely relieves the symptoms. Chronic lesions sometimes result from caisson disease, the most important being impairment of hearing, paralysis from spinal cord damage, and disturbances of the bones and joints.

Pains in the extremities in the early stages have often been referred to as in the joints, particularly the hips, less often the knees, ankles, and shoulders. In most instances they clear up but in some cases symptoms and signs similar to those of chronic deforming arthritis have continued. Chronic pains in the course of the bones have also been present in some cases.

Bornstein and Plate and independently Bassoe were the first to describe joint lesions in caisson disease. Bornstein and Plate in 1911 reported 3 cases in which symptoms and signs were present resembling chronic arthritis. A shoulder was involved in one case, one hip in another, and both hips in the third case. Roentgenograms of the hips revealed mottled changes in density in the head of the bone with flattening of its articular surface, irregularity and slight narrowing of cartilage space, and marginal lipping. The findings were considered those of arthritis deformans but they thought that the lesion was due to nitrogen bubbles in the bone bordering on the joint and not to nitrogen in the joint. No more detailed definition of the lesion was attempted.

In his report on the late manifestations of compressed air diseases Bassoe described deforming changes in the joints and also changes

in the bones away from the joints. There were 2 cases of involvement of the hip, 1 of 11 and the other of 13 years standing, in which roentgenologically the head showed mottling and flattening and there was narrowing of cartilage space and lipping which led to a diagnosis of arthritis deformans. In another case there was a similar change in the head of the humerus and lipping of the glenoid margins.

Twynam in 1888 reported the case of a man who had severe symptoms of caisson disease with pain and swelling above the right knee and 2 months from the onset abscess formation which was drained. Later on there was another painful swelling about the right trochanter which was drained and sinuses persisted for 2 years, at which time amputation was performed through the lower third of the femur. The entire shaft of the femur was found to be necrotic and there was involucrum one third of an inch thick surrounding it. This appears to have been a case of massive necrosis of the shaft of the femur with secondary infection which resulted in a picture resembling closely that of pyogenic osteomyelitis.

Chronic changes in the cancellous bone away from the joints was noted roentgenologically by Bassoe three times, once in the upper and once in the lower diaphysis of the tibia and once in the lower epiphysis of the fibula. There were mottled areas of absorption and irregular lines of new bone formation. No definite interpretation was made of these bone changes and there were no reproductions of the roentgenograms in the article. Fortunately, the roentgenograms of the tibial lesions have been preserved and with Dr Bassoe's permission they were compared with roentgenograms showing tibial lesions in some of the cases here reported and found to be quite similar.

A number of reports have since been made of the joint changes in caisson disease. Plate in 1918 reported a case and considered the change to be analogous to arthritis deformans. Burkhardt classified caisson lesions of the joints under the category of arthritis deformans but considered the primary lesion most likely in the adjacent bone. Christ in 1934 published a very comprehensive review



Fig 3

Fig 3 Case 1 Central necrotic area in the shaft of the left femur. The calcified and ossified zone of demarcation and the calcified necrotic island in the external condyle, 1, are clearly shown.



Fig 4

Fig 4 Case 1 Loose bodies in shoulder joint and walled off necrotic area in upper half of humerus.



Fig 5

Fig 5 Case 1 Sclerosed patches in upper diaphysis of tibia.

protein nitrogen of the blood and died December 5, 1937.

**Autopsy** At autopsy the following anatomical diagnoses were made: bronchiogenic carcinoma of the right lung with extension into the superior vena cava, chronic nephritis, cardiac hypertrophy and dilatation, arteriosclerosis, most marked in aorta, duodenal ulcer (five small ulcers), cholelithiasis, cicatrices and pigmentation of legs, scoliosis, ancient, infarcts, ancient, massive, in shafts of both femurs and left humerus and minimal in shaft of left tibia, arthritis, chronic, deforming, of hips and left shoulder secondary to necrosis of heads of femurs and humerus, osteocartilaginous loose bodies in left shoulder and right hip.

The entire right upper lung lobe was involved in carcinoma originating in the bronchus. It penetrated and largely blocked the superior vena cava near its termination. No distinct tumor metastases were found. The heart was moderately hypertrophied but the coronary vessels were patent and smooth throughout. The heart valves appeared normal. There were no signs of infarcts, old or recent, in heart muscle, kidneys, spleen, or brain.

**Skeletal structures** There was marked right lumbar scoliosis with conspicuous articular proliferation. The trunk bones otherwise showed no outward

changes. The right sixth rib was removed and sectioned. No abnormalities were seen. The left scapula and humerus, both innominate bones, both femurs, and the left tibia were removed. When the left shoulder was opened marked villous proliferation of the synovial membrane and thickening of the capsule were noted. It contained seven osteocartilaginous loose bodies ranging from 1 to 2 centimeters in diameter, some of which were flattened and nodular. The articular cartilage of the glenoid was somewhat frayed but there was no marginalipping or change in the underlying bone. Roentgenograms showed the same changes in the bones as were present at the examination on admission.

**Left humerus** The head of the humerus was flattened and its articular surface rough with marked proliferation of the surrounding borders. The articular cartilage was markedly thinned and in places entirely wanting. Section of the humerus (Fig 6) showed 2 cystic areas in the head containing necrotic and gelatinous material. The proximal half of the shaft presented an irregular circumscribed area of necrosis of the medullary portion. It measured 17.5 centimeters in length and varied in width from 20 millimeters in the proximal portion to 4 millimeters in the distal portion. It was surrounded



Fig. 2. Case 1. Central necrotic area in shaft of left femur with calcified and ossified zone of demarcation.

the cartilage spaces and marginal lipping especially on the right side. There are scattered areas of reduced density in the subarticular portion of the femoral heads and acetabula interspersed with areas of increased density.

Anteroposterior and lateral roentgenograms of the lower three fourths of the left femur reveal an oblong area of altered density in the medullary region beginning 2½ centimeters above the condyles and extending upward for a distance of 18 centimeters (Fig. 1). It occupies almost the entire width of the medullary cavity below and tapers off irregularly above. It is surrounded by a narrow irregular zone of increased density most marked along the mesial and posterior sides. The density of the interior is mottled being lightly increased in most of its extent as compared with that of the normally appearing cancellous bone below the lesion. The shadow of the cortex surrounding this area shows slightly longitudinal streaking but the shaft is not increased in thickness.

A roentgenogram of the right femur shows a similar area in the same region (Fig. 3). The area is 19 centimeters long and is 4.5 centimeters broad at

the lower end in the anteroposterior view. There is a narrow dense zone about the periphery in almost its entire extent. Just beyond its upper limit there is a separate island 1 centimeter in diameter with a dense zone about its periphery. There is a dense streak within 3 centimeters above the lower end in the anteroposterior view and another crossing the involved area transversely 10 centimeters above the lower end seen in the lateral view. The cortex surrounding the area is longitudinally streaked in places and appears lightly irregular in outline in the anteroposterior view. There is a dense island in the external condyle of femur. The areas in the femurs are interpreted to represent masses of old aseptic dead bone that have had a calcareous capsule laid down about them.

A roentgenogram of the left shoulder joint and humerus shows extensive changes. There is humerus tapering downward for a distance of 20 centimeters (Fig. 4). There is a slight flattening of the articular cortex and slight bony overgrowth at the lower margin of the head of the humerus. There is a dense shadow resembling an osteophyte or loose body at the upper margin of the glenoid and another mesial to the surgical neck of the humerus just below the glenoid margin. There is a mottled increased density in the mesial portion of the upper end of the shaft extending to the anatomical neck and into the upper portion of greater tuberosity. There is an oval area 7 centimeters long extending downward in the shaft of the humerus with a zone of increased density about its periphery most marked at the upper and lower ends. The interior of this area is somewhat mottled in appearance and there is a faint network of increased density extending down the medullary canal from this.

A roentgenogram of the left tibia shows regular lines of sharply increased density extending slightly obliquely across the shaft in the medullary region 12 centimeters below the knee joint (Fig. 5). There is also an island of slightly increased density in the mesial portion of the upper end of the shaft about 1.5 centimeters in diameter though hazy in outline. There is a narrow transverse line partly traversing the medullary region about 7 centimeters above the lower end of the shaft of the tibia which has the appearance of an old growth arrest line. Roentgenograms of the lower thoracic and lumbar spine reveal the end stage change of moderate adolescent scoliosis without any evidence of lesions in the bones of the type seen in the humerus, femurs and tibia.

Roentgenograms of the chest including the cervical spine reveal no changes in the ribs, clavicles and spine in the spine and ribs except those resultant from scoliosis. There is a large area of increased density in the region of the right upper lobe which is sharply outlined.

The lung condition was diagnosed as bronchiogenic carcinoma. The patient's chest symptoms fluctuated during the next few months but the cough continued. He gradually lost strength and developed edema of the dependent portions with increased non-

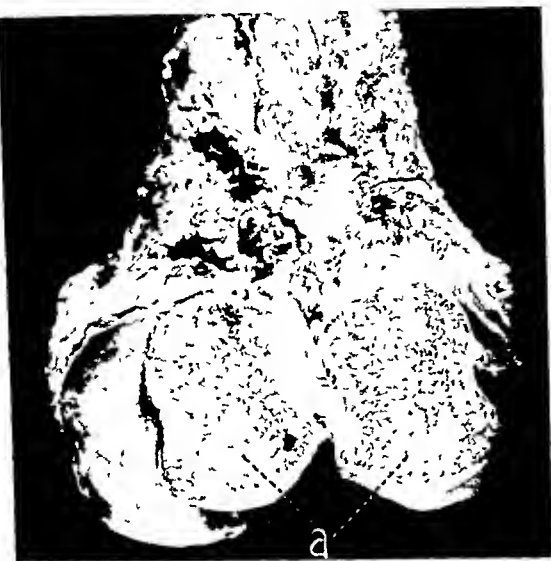


Fig 8 Case 1. Coronal section of posterior portion of external condyle of right femur, showing calcified necrotic area

from the synovial lining. The head was flattened and conical in shape although less pronounced than on the left side. There was an osteocartilaginous body attached by a thin pedicle to the inferior portion of the capsule. Articular cartilages were destroyed on the superior surface of head and opposing surface of the acetabulum and there were marginal osteophytes on both head and acetabulum.

Coronal sections were made of the right femur (Fig 7) and iliac bone extending through the acetabulum. Section of the acetabulum showed sclerosis of the bone bordering on the articulation to a depth of 1 to 2 centimeters and two cavities  $\frac{1}{2}$  and  $\frac{3}{4}$  centimeter in diameter in the weight-bearing region. One was filled with fibrous tissue and one with fluid (Fig 12). There were also marginal osteophytes. The bone away from the acetabulum was normal in appearance. Section of the femur showed loss of articular cartilage on the weight-bearing portion of the head, with only a thin layer along the inferior portion. The underlying cancellous bone was sclerotic and contained several small cavities, some filled with fibrous tissue and some with fluid. A yellowish dark area at the base of the upper part of the neck of the femur appeared to be calcified infarct. The cortex and medullary portions of the shaft from there down to the middle had a normal appearance. In the lower half of the shaft there was a necrotic area with a dense surrounding zone of demarcation of approximately the same size and location as that seen in the left femur. The roentgenogram revealed a dense mottled area in the posterior part of the external condyle of the right femur. A section through this region (Fig 8) revealed a yellowish, hard, amorphous blotchy area averaging  $1\frac{1}{2}$

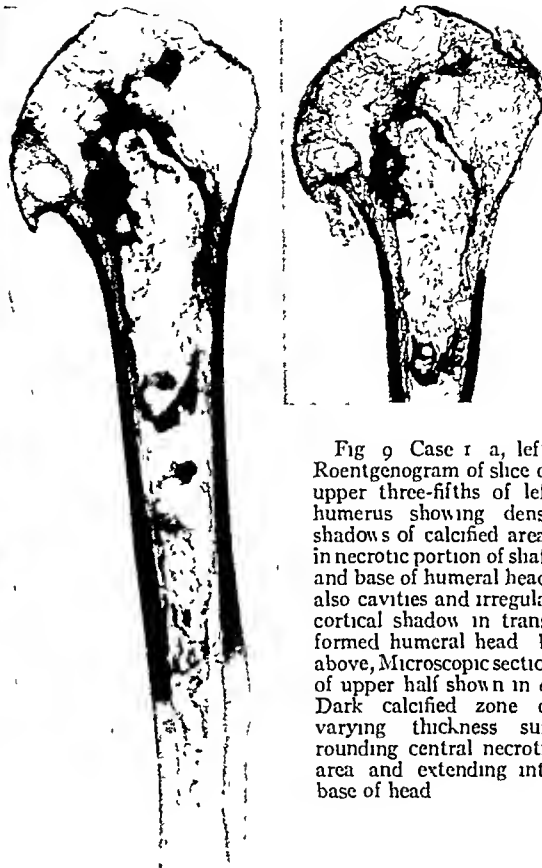


Fig 9 Case 1 a, left, Roentgenogram of slice of upper three-fifths of left humerus showing dense shadows of calcified areas in necrotic portion of shaft and base of humeral head, also cavities and irregular cortical shadow in transformed humeral head b, above, Microscopic section of upper half shown in a. Dark calcified zone of varying thickness surrounding central necrotic area and extending into base of head

centimeters in diameter which also looked like a necrotic calcified region. The epiphysis otherwise and the knee joint were normal in appearance.

The left tibia was normal in external appearance. On section a mottled, grayish yellow, blotchy streak was found in the medullary cavity of the shaft 10 centimeters below the upper end of the bone. There was also an irregular area of slight sclerosis in the cancellous bone of the lateral portion 2 centimeters below the epiphyseal line.

Slices  $\frac{1}{2}$  to 1 centimeter thick were cut from the upper three-fifths of the left humerus, the left glenoid, the upper two-fifths of the left tibia, the entire length of the femurs and the acetabula and iliac bones. Roentgenograms of the slices brought out sharply the dense zones of demarcation about the necrotic areas and the blotchy areas of increased density irregularly distributed within them, also the subarticular sclerosis and cavities in the femoral and humeral heads. Large microscopic sections were prepared of the slices of bone, also sections were made of the villous linings of the shoulder and hip joints and of one of the loose bodies which were present in the shoulder.



Fig 6 Case 1 Central necrotic area in upper half of diaphysis of left humerus Deforming arthritis in humeral head and 7 osteocartilaginous loose bodies in shoulder joint

by a dense wall which varied greatly in thickness at different levels being thickest at the upper and lower limits. The center contained brownish to grayish friable debris and there were calcareous bridges crossing its middle portion. The cortex of the upper half of the shaft was approximately normal in appearance but there was an irregular zone of cancellous bone of increased density between it and the wall of the central necrotic area. The lower half of the humerus and the elbow joint were normal.

The capsule of the left hip was somewhat thickened and the synovia showed moderate villous arthritis with lymphocytic infiltration. The femoral head was markedly flattened devoid of articular cartilage and surrounded by marginal osteophytes. There was destruction of articular cartilage of the glenoid which was changed in shape to fit the altered head and there was a long osteophyte extending outward from the superior margin of the acetabulum. There was also a marginal osteophyte in the region of the cotyloid notch. An osteocartilaginous body was attached by a pedicle to the inferior portion of the capule.



Fig 7 Case 1 Section of femur showing remnants of infarcts in lower half and resolved but deformed femoral heads. Partly calcified incompletely resolved area of necrosis at o

Coronal sections were made of the left femur (Fig 7) and left innominate bone passing through the hip joint. The acetabular portion of the innominate bone showed marked sclerosis with a few scattered cystic areas in its mesial portion. The bone away from the acetabular region was normal in appearance.

The shaft of the left femur was normal to external appearance. The cut surface of the flattened head showed it to consist of irregular dense bone surrounding cystic areas beneath the articular surface and extending into the proximal portion of the neck. Osteophytes were most marked at the lower margin. The remaining portion of the neck and upper half of shaft of the femur appeared normal. The distal half of the shaft contained an encapsulated area of necrotic grayish friable debris measuring 15 centimeters in length and varying in width approximately from 4 millimeters at its upper end to 25 millimeters at its lower end which extended to within 2 centimeters of the epiphysis. It was surrounded by a dark hard zone varying from  $\frac{1}{4}$  to  $\frac{1}{2}$  centimeter in thickness. There were areas of cancellous bone and calcareous deposit within the necrotic debris. The cortex surrounding the necrotic area was approximately normal in appearance but there was sclerosed cancellous bone about the dense capsule. The lower epiphysis, articular surface of the femur and the lining of the knee were normal in appearance.

**The right hip** The capsule of the right hip was also thickened and there were many villi springing



Fig 12 Case 1 Microscopic section of the upper portion of the right femur and of the acetabulum showing deforming arthritis

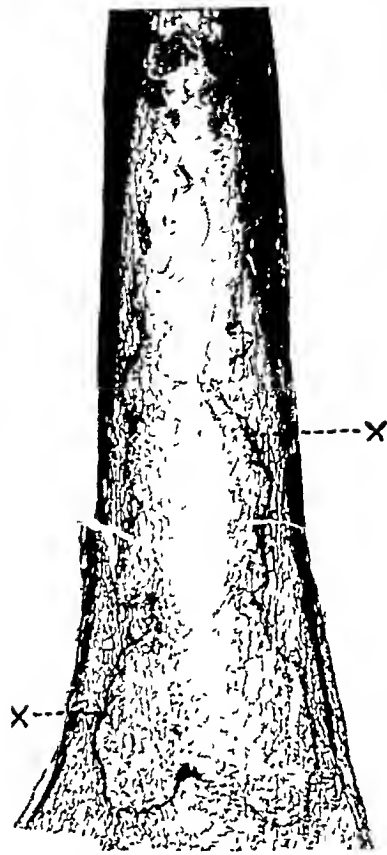


Fig 13 Case 1 Microscopic section of lower half of shaft of right femur showing central necrotic area and calcified zone, x, about its periphery

cartilage. These changes gave rise secondarily to villous synovitis and osteocartilaginous loose bodies. A section of one of the loose bodies showed it to consist of a center of calcified fibrocartilage and an outer portion of irregularly laminated fibrocartilage and calcified cartilage.

Figure 11 is a roentgenogram of coronal slices of the right femur and acetabulum and Figure 12 a microscopic section of the upper portion of the femur and acetabulum.

The changes in the head of the femur and acetabulum were similar to those in the head of the humerus. Microscopically, the articular surfaces on both sides of the joint were covered by an irregular layer of fibrocartilage. In places it was incomplete and bare sclerosed bone with fibrous marrow bordered on the joint. There were subchondral cavities filled with fibrous tissue or with coagulum and there was marked osteophyte formation at the limits of the articular surfaces. The synovia showed a villous arthritis and there was a small island of bone imbedded in capsule at the inferior portion of the joint. At the base of the neck both mesially and laterally

there were irregular islands of calcified fibrous marrow indicative of ancient bone necrosis. The head presented the picture of ancient aseptic necrosis with secondary collapse, invasion, and transformation similar to that which has been observed following intracapsular fracture of the neck with necrosis of the head, bony union of the fracture and subsequent weight bearing.

The rest of the upper diaphysis showed no change. Microscopic examination of a section of the lower half of the shaft of the right femur (Fig 13) revealed a central area of necrosis of cancellous bone and marrow with a small amount of granular calcification similar to that seen in the upper diaphysis of the humerus. The dead trabeculae were unaltered in form as can be seen in Figure 12. There was a surrounding narrow zone of demarcation of calcified and partly ossified connective tissue. In places the connective tissue had grown for short distances into the necrotic zone, and in the upper limits were broad bands and islands of calcified tissue. There was a surrounding zone of living trabeculated bone and marrow, except at the upper end where the calcified

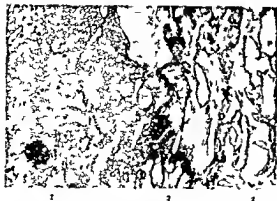


Fig 10 Case 1 Section of wall about necrotic area in Figure 9 b showing 1 necrotic bone and marrow with calcareous islands 2 fibrosed calcified and partly ossified wall 3 surrounding living cancellous bone and marrow

Figure 9 shows the appearance of the roentgenogram of the slice cut from the humerus and of a microscopic section of the upper half of the slice. Under the microscope the central region of the shaft was found to consist of necrotic cancellous bone and marrow with blotchy areas of calcification. About the upper and lower limits of the necrotic area there was a broad layer of heavily calcified connective tissue and debris. Along the sides the zone of demarcation was much narrower. The lateral wall consisted of a narrow zone of calcified tissue in its upper three fourths and of uncalcified dense fibrous tissue in its lower fourth. There was also an uncalcified fibrous wall along the lower two thirds of the mesial wall. Surrounding this zone were living cancellous bone and fatty marrow. A microscopic section of the calcified lateral wall is shown in Figure 10. The internal portion consisted of small trabeculae with empty lacunae and of necrotic marrow. The outlines of the dead fat cells were remarkably well preserved. They were generally filled with an albuminous substance (*edema ex lacuna*). There were in places large and small calcareous granules. The zone of demarcation consisted of fibrous tissue which was extensively calcified and in places had been transformed into bone. It incorporated some dead trabeculae which had not yet been absorbed and replaced by new bone. Outside of this was living cancellous bone and fatty marrow. The humeral head was flattened and contained three cystic areas—two in its lower part and one in its upper part. They were filled partly with a coagulum and partly with fibrous tissue. The joint surface of the superior and lateral portion of the head was covered with normal articular cartilage and underlying cortex. The rest of the head was covered with an incomplete thin layer of fibrocartilage and the articular cortex was bare and sclerosed in places. There was an osteophyte at the lower limit of the articular surface and a notch at the junction of the normal and transformed articular surfaces at the top of the head.



Fig 11 Case 1 Roentgenogram of slice of right femur and acetabulum showing arthritis deformans and walled off infarct in lower half of femoral shaft

Numerous villi sprang from the synovia. At the base of the head in its upper portion a partly transformed calcified necrotic zone separated it from the greater tuberosity.

The changes in the head are best explainable on the basis of a massive necrosis of all except the superior and lateral portion with death of overlying articular cartilage. The subsequent changes have consisted in gradual invasion, absorption and replacement of the necrotic portion by cancellous bone and cystic cavities and calcified tissue at its base. The dead articular cartilage has been partly replaced by an incomplete layer of thin fibro-



Fig 16.

Fig 16 Case 2 Necrosis of heads of femurs in caisson disease of 4 years' duration with sequestration of superior portions from weight bearing

Fig 17 Case 2 Left shoulder Large portion of head of humerus shows irregular reduction in density with zone of increased density about it



Fig 17

less demarcated from the surrounding head by the zone of reduced density. Its articular surface was dense, smooth, and depressed mesially where it extended to the fovea. The bone of the head and neck surrounding the demarcated area was somewhat mottled and increased in density. The shadow of articular cortex of acetabulum was intact and the cartilage space of the joint was approximately normal in width.

Roentgenograms of the shoulder showed blotchy reduction in density with a surrounding zone of increased density in the head of each humerus, more marked in the left (Fig 17).

The diagnosis was made of caisson disease producing large areas of aseptic necrosis in the heads of the femurs, which, as a result of too much weight bearing, had been separated from the surrounding living bone. A biopsy was performed of the left hip by Dr Walker. The cartilage looked pale. With a gouge some bone was removed from the neck of the femur. Aerobic and anaerobic cultures and guinea pig inoculations for tuberculosis gave negative results. Evidently the lesion of the head was not entered as microscopic sections of the bone removed showed atrophic living bone with an increase of fat and in some places of fibroblasts in the marrow spaces.

The patient remained in the institution with little change in his condition. February 9, 1935, a roentgenogram of the hips showed slight progression of the disease, the separated area of the head of the right femur being slightly more depressed. May 1, 1935, because of continued pain in the right hip an operation was performed at which cartilage and necrotic bone were removed, reducing the head to about one-fourth its normal size. Microscopic sections were made of a piece of the excised head. It contained bony trabeculae, the lacunae of which were entirely devoid of cells. The marrow spaces were partly filled with white fibrous connective tissue much of which was necrotic and in places the bone was being eroded along its surface. The microscopic

picture was that of aseptic necrosis of bone with subsequent invasion and partial absorption by connective tissue. The patient after a few months walked in a caliper splint but the joint continued to be weak and painful and he was unable to work. A roentgenogram of the left hip taken 3 years after the first showed only slight progression of the process.

CASE 3 B W, male, aged 54 years, was admitted to the University of Chicago Clinics, January 3, 1938, because of spastic paralysis in the lower extremities. In 1908 while working at bridge construction he came out of a caisson of 40 pounds' pressure in 5 minutes. Twenty minutes later he suffered severe pains in the abdomen, arms, and legs, and was removed to a hospital. There he developed in addition paralysis of the lower extremities and bladder and was confined for 4 months. The pains gradually disappeared but the limbs remained weak and became spastic.

Since 5 months after the injury the patient had walked with a cane but always with great difficulty. Sexual impotence had been present since the injury. He had had no pains in the limbs until 2 years ago since which time there had been frequently a dull ache, especially at night, over the lower half of the right tibia.

*Past history* Patient could not recall any case of illness before accident in 1908, no history of venereal infection.

*Physical examination* revealed a well nourished male, weight 200 pounds, blood pressure, 150/90. Regional examination aside from the lower extremities was essentially normal, except for the right pupil which was slightly larger than the left and both pupils reacted sluggishly to light. He walked slowly with a spastic gait. Both lower extremities were spastic and movements of the joints were carried out with difficulty. The patellar and Achilles reflexes were exaggerated and clonus was easily incited. The hip, knee, and ankle joints showed no palpable changes but motion was restricted in them due to the spasticity. There was hypesthesia and marked dimi-





Fig 14 Case 1 Wall of necrotic area a Necrotic bone and marrow within b calcified fibrous zone of demarcation c surrounding living cancellous bone and marrow  $\times 25$

wall merged with the compact cortex laterally. Figures 14 and 15 show the microscopic appearance of the zone of demarcation.

The articular cartilage and synovial lining of the knee joint were normal which would indicate that the necrotic lesion did not primarily reach the articular surface of the joint. A microscopic section of the yellowish dense area in the posterior part of the external condyle showed it to consist in its deeper portions of old dead bone with cancellous spaces filled with a partly calcified sparsely cellular connective tissue. In its peripheral portion were living bony trabeculae and the lesion was surrounded by living cancellous bone and fatty marrow. Microscopic examination of the yellowish dense area in the upper third of the shaft of the left tibia showed a picture similar to that in the external condyle of the femur. These were obviously old areas of necrosis with fibrous invasion, calcification and incomplete replacement by new bone. The one in the condyle of the femur appeared to be an infarct which arose separate from that in the diaphysis.

CASE 2 L. O. B. aged 37 years was admitted to the Veterans Administration Dayton Ohio in June 1934 because of pain and stiffness in both hips of 4 years duration. He states that in 1930 while working in a cannery there was leakage of gas from a neighboring plant and the crew was hurriedly taken out without gradual decompression. The patient developed the bends and was placed in a recompressor. On removal the attacks recurred so that he was returned to the recompressor and kept for 1 day. He was sent to a hospital with bleeding from the ears, nose and mouth and delirium which necessitated restraint. Ecchymoses developed in the skin of various parts of the body. He has had pain in the hips and legs from the time of admission to the hospital to the present although in diminishing severity, also some pain and stiffness in the shoulders. In 1931 he went into compressed air again to see if it



Fig 15 Case 1 High power view of zone of demarcation a Necrotic border b calcified zone c surrounding living bone

would benefit his hips. He thought the pressure affected his heart and the joints were not benefited. The pain and stiffness in the hips have advanced to a point where he has had to discontinue all work.

**Past history.** He was a steam fitter before being a cannery worker. He has had the usual diseases of childhood and smallpox, influenza and pneumonia, gonorrhea in 1923. He denies having syphilis. No history of joint trouble was elicited before the onset of the cannery disease. He suffers from headaches and attacks of dizziness. He smokes and drinks alcoholics moderately.

**Physical examination.** The patient is short stocky and somewhat overweight. He walks carefully with a waddling gait. Regional examination is essentially negative aside from the hips and shoulders. There is slight limitation of motion in both shoulders more marked in the left. Motion in the hips is limited in all directions to about one half normal and forced motion is painful. There is normal range of motion in the ankles and knees.

**Laboratory findings.** Basal metabolic rate was -10 blood Wassermann and Kahn negative. Cytology and chemistry of blood analyses including calcium, phosphorus and uric acid were within normal limits.

**Roentgenograms** were taken of the hips (Fig. 16). The head of the left femur showed a large spherical area of mottled density in the weight bearing portion including the joint surface and extending to the junction with the neck. It was separated from the surrounding bone by a broad zone of reduced density and its articular surface was depressed 3 to 4 millimeters. The rest of the articular surface of the head and that of the acetabulum appeared even in outline and the cartilage space was of normal width. The medial and inferior portions of the head were slightly increased in density and there was haziness and slight increase in density of the bone surrounding the demarcated spherical area and extending downward into the adjacent portion of neck.

The right femur showed a similar area in the same region of the head which was larger, more dense and



Fig 21

was like that of Case 1 and very different from that seen in bone syphilis. No treatment was advised for the caisson disease but treatment was recommended for the lues.

**CASE 4.** L. P., male, aged 55 years, entered the University of Chicago Clinics, April 11, 1938, because of long-standing stiffness and pains in the hips, knees, and shoulders. In February, 1917, the patient worked for 8 hours in a caisson with pressure of 20 pounds. He came out in 4 minutes and 30 minutes later developed severe pains in the abdomen, legs, and arms. He had hemoptysis and hematemesis and was very ill for several days. He gradually improved and in 3 months was able to work but still had pains in both upper and lower extremities. Five months after the accident he had to give up work because of stiffness and soreness in the hips. These symptoms have persisted and he has gotten around with increasing difficulty. Pain and stiffness in the shoulder have also continued. Swelling developed in the lower legs and the skin became discolored with the development of leg ulcers. He has been unable to do any kind of work for several years.

Past history disclosed the usual diseases of childhood and gonorrhea at 19 years.

Physical examination revealed a well nourished male who moved about with great difficulty. Regional examination was essentially negative aside from the extremities. There was limitation of elevation of the arms to about 90 degrees and forced motions caused pain in the shoulders, marked



Fig 22

**Fig 21.** Case 3. Demarcated zone and dense areas within shaft of left femur.

**Fig 22.** Case 3. Upper end left tibia. Involved area densest about periphery. Involved fibula equally dense throughout.

**Fig 23.** Case 3. Both ends left tibia and upper end of fibula involved.



Fig 23



**Fig 24.** Case 3. Blotchy dense area in metaphysis of humerus. Head and shoulder joint unchanged.



Fig 18 Case 3. Walled off zones of increased density within shafts of right femur and tibia.

nution in tactile sense below the knees. Blood Wassermann 4 plus. Kahn 3 plus.

Roentgenograms were made of the entire skeleton. Areas of increased density were revealed within the shafts of the lower ends of the femurs, the upper ends of the fibulas, and the upper and lower ends of the tibias. In the right femur the lower three fifths of the shaft was involved. There was a dense irregular zone of demarcation at the junction of the cancellous and cortical bone of the metaphysis and irregularly along the walls of the medullary cavity above (Fig 18). A similar condition was seen in the upper third of the shaft of the right tibia and in the upper metaphysis of the right fibula (Fig 19). There was a similar dense blotchy area in the lower end of the right tibia 6 centimeters long beginning 1½ centimeters above the epiphyseal line (Fig 20). In the left femur the involvement began just above the lower epiphysis and extended upward throughout three fifths of the shaft (Fig 21). The lesions in the



Fig 19 left Case 3. Demarcated dense zones in upper portions of right tibia and fibula.

Fig 20 right Case 3. Right tibia and fibula. Lower metaphysis involved in tibia and free in fibula.

left tibia and fibula resembled those of the right (Figs 22 and 23). The left humerus showed a pointed area of increased density in the region of the lesser tubercle. There was no change in the head of the humerus or shoulder joint (Fig 24). Roentgenograms of the rest of the skeleton revealed no abnormal changes. It was particularly noteworthy that the heads of the femurs and hip joints were uninvolved.

**Diagnosis.** The condition was diagnosed as a late stage of caisson disease with spastic paraplegia of the lower extremities and areas of incompletely resolved and calcified aseptic necrosis of the femurs, tibias, fibulas and left humerus. Lues was diagnosed because of the positive Wassermann and Kahn tests and the sluggishness and inequality of pupil. But the roentgenographic appearance of the bone lesions

R



Fig 27



Fig 28



Fig 29

L



Fig 27 Case 4 Central involved areas in shafts of right femur, tibia, and fibula hazy in outline and slightly increased in density

Fig 28 Case 4 Hazily outlined central increased density in shaft of femur, greatest in metaphysis

Fig 29 Case 4 Blotchy dense areas in medullary canal and metaphysis of tibia

tion of the hip, fracture of the neck of the femur followed by bony union (Phemister) and idiopathic necrosis in adults (Chandler)

The lesions in the shafts are remarkable in that they are much more numerous and extensive than in any case of bland infarction or aseptic necrosis of bone found reported. The necrosis was of the interior of the diaphysis in all instances and because of the long time that had elapsed since the initial lesion it was difficult to know how much if any of the internal portion of cortex was involved. Creeping invasion and substitution of the dead bone by new bone may have reduced materially the size of the necrotic area before the process came to a standstill with calcification of the surrounding fibrous zone. Preservation of circulation to the cortex would tend to guard against the occurrence of pathological fracture but the presence of central necrosis producing weakness of bone would set up a reparative stimulus leading to creep-

ing replacement of some of the dead bone by new bone. Once the diaphysis is sufficiently strong to support the part, the stimulus for substitution would come to a standstill and the remaining portion become encapsulated. One reason why these large diaphyseal lesions have not been heretofore recognized may be the slightness or absence of associated symptoms and the failure of occurrence of pathological fractures. On the other hand, the pains in the limbs during both early and later stages are doubtless due in some cases to the bone necrosis.

It is difficult to state whether the lesions in the bones produced by the nitrogen gas were the result of nitrogen embolism or of nitrogen accumulation within the medullary cavity and direct compression of blood vessels and other tissues or a combination of the two. Lesions of the soft parts are known to be produced by both methods. Points in favor of nitrogen embolism are: (1) The lesions were frequent (in three cases) in the heads of femurs where end arteries are known to be frequently found, (2) the metaphyses of the lower end of the femur and of upper end of fibula and both ends of tibia were affected in some cases while their epiphyses escaped,



Fig. 25 Case 4 Left hip deformed with sequestrum at top of flattened transformed femoral head. In right hip are noted osteophytes and mottled density of head.

limitation of motion in all directions in both hips, knee and ankle motion was slightly limited.

Moderate swelling of the lower half of the legs was noted and also brown induration pigmentation and small ulceration of the skin were present. Little muscle weakness was found in the legs and forearms. The reflexes were normal throughout. No disturbance of sensation of the skin was noted in any part of the body. Blood pressure was 130/76. Urine and blood examinations were essentially negative. Wassermann and Kahn tests were negative.

Roentgenograms were made of the entire skeleton. Extreme deformity of both hips was noted more marked in the left (Fig. 25). The head of the left femur was flattened and the underlying bone was irregularly increased in density. The depressed dense area at the middle of the top appeared to be a detached piece of necrotic cortex such as is often seen in the collapsed femoral head that is necrotic following traumatic dislocation of the hip fracture of the neck of femur, slipped epiphysis or Legg-Perthes disease. The cartilage space of the joint was narrowed and there was marked osteophyte formation at the acetabular margins. The right hip showed narrowing of the cartilage space of the joint, increased density and mottling of the head of the femur andipping of the lower articular margins of the head and of the upper margin of the acetabulum. There was a half moon shaped shadow of blotchy increased density in the upper portion of the head of the left humerus bordering on the articular surface which was irregular in this region (Fig. 26). The greatest increase in density was at the junction of head and neck and there was a narrow irregular streak of increased density extending downward for approximately 3 centimeters into the shaft. The right humerus showed a similarly situated area of increased density which was more uniform and the articular surface of the area was somewhat irregular and flattened. The process did not extend into the shaft of the humerus.

Somewhat hazily outlined areas of increased density were apparent in the interior of the diaphyses of the lower ends of the femurs, both ends of the tibiae and questionably the proximal end of the humeri as seen in Figures 27, 28 and 29. The appearance differed from that of the corresponding

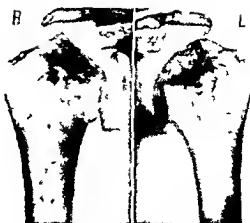


Fig. 26 Case 4 Mottled increased density in head of each humerus with extension into metaphysis of left.

leg bones in Cases 1 and 3 in that dense lines of demarcation had not yet formed about the periphery of the lesions. The epiphyses of all three bones were free of involvement and no changes appeared in the joint spaces.

A diagnosis was made of caisson disease with necrosis and partial replacement by new bone and partial calcification in the heads of the humeri and femurs and necrosis with less complete reorganization and calcification in the diaphyses of femurs and tibiae.

In view of the similarity of roentgenographic changes in the bones and joints in the 4 cases and of the established nature of the pathology in Cases 1 and 2 the evidence appears to be conclusive that the primary lesion is an accumulation of nitrogen gas in the bones—whether intravascular or extravascular will be discussed later—with interference of circulation and a resultant massive aseptic necrosis. In the head of femur or humerus the necrotic lesions may break down and be invaded and eventually replaced by new bone or fibrous tissue. Invasion of portions of the epiphysis may be followed by calcification and arrested transformation especially in portions of the epiphysis away from the articular surface. Involvement of articular cortex and cartilage leads to the slow development of arthritis deformans with or without osteocartilaginous loose bodies. These changes are in keeping with those seen in the head of the femur and hip joint years after interruption of blood supply of the head of femur as by slipped epiphyses certain cases of traumatic disloca-



Fig. 27



Fig. 28



Fig. 29



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Fig. 25. Case 4. Left hip deformed with episternum at top of flattened transformed femoral head. In right hip are noted osteophytes and mottled density of head.

limitation of motion in all directions in both hips. Knee and ankle motion was slightly limited.

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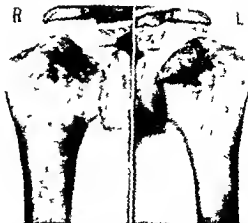


Fig. 26. Case 4. Mottled increased density in head of each humerus with extension into metaphysis of left.

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In view of the similarity of roentgenographic changes in the bones and joints in the 4 cases and of the established nature of the pathology in Cases 1 and 2 the evidence appears to be conclusive that the primary lesion is an accumulation of nitrogen gas in the bones—whether intravascular or extravascular will be discussed later—with interference of circulation and a resultant massive aseptic necrosis. In the head of femur or humerus the necrotic lesions may break down and be invaded and eventually replaced by new bone or fibrous tissue. Invasion of portions of the epiphysis may be followed by calcification and arrested transformation especially in portions of the epiphysis away from the articular surface. Involvement of articular cortex and cartilage leads to the slow development of arthritis deformans with or without osteocartilaginous loose bodies. These changes are in keeping with those seen in the head of the femur and hip joint years after interruption of blood supply of the head of femur as by slipped epiphysis, certain cases of traumatic dislo-

and contractures of the hind limbs. Animal was sacrificed in 155 days. The spinal cord was examined by Dr Cloward. It showed marked degeneration in distribution of anterior spinal artery of lumbosacral region. The muscles of the hind limbs were dissected from the skeleton. In places they were pale and shrunken, especially the adductors. Microscopic sections showed extensive-scattered replacement by fat. The bones of the hind limbs were roentgenographed, split open, and the left femoral head was sectioned for microscopic study. No changes were found aside from slight atrophy.

Twelve cubic centimeters per kilogram body weight injected in one dog caused death in 10 minutes from embolism.

Ten cubic centimeters per kilogram body weight injected in another animal caused death over night from embolism.

Six and seven-tenths cubic centimeters per kilogram body weight injected in one dog caused no symptoms afterward. Animal was sacrificed in 94 days. The bones of the hind limbs were roentgenographed and split and microscopic sections were made of the head of left femur. No pathological changes were found in the bones.

The absence of necrosis in the bones of the 4 dogs whose hind limbs were partly or completely paralyzed by the air embolism may possibly be considered as evidence favoring the view that the bone lesions in caisson disease are due rather to gas liberated in the medullary cavity under sufficient pressure to asphyxiate the tissues than to embolism.

#### SUMMARY

The literature of skeletal lesions of caisson disease is reviewed.

Four cases of caisson disease of long standing in adult males are reported in which there was evidence that multiple infarction of large to small portions of long bones occurred as a result of damage by liberated nitrogen gas. All cases were studied clinically and roentgenologically, and the diagnosis was confirmed in one case by autopsy and in another by biopsy.

Late changes in the necrotic areas varied with the location and duration of involvement.

When the necrotic bone was situated in the epiphyses and bordered on joints, varying amounts of collapse of the weight-bearing portions, invasion and replacement by new bone, and calcification of non-substituted portions were noted. Articular cartilage overlying involved areas broke down and was

replaced by fibrocartilage and more or less extensive arthritis deformans was established, accompanied in some instances by the formation of osteocartilaginous loose bodies. Support is furnished for the theory that arthritis deformans may be due to vascular blockage and necrosis of bone underlying articular cartilage.

When the necrotic bone was situated in the diaphyses or in epiphyses away from the articular surfaces, collapse did not occur and there was evidence of some invasion and replacement by new bone, as judged by the presence of irregular cancellous living bone surrounding and even penetrating the persistent areas. Complete replacement of some of the smaller areas had probably come about. But in the case of large areas replacement after advancing to the point of restoring approximately normal strength to the bone, came to a standstill as shown by repeated roentgenographic studies at long intervals, and the fibrous wall about them became more or less extensively calcified and ossified. Small necrotic areas were found, as one in the femoral condyle, invaded by connective tissue and extensively calcified. Scattered calcification also took place to some extent in the large central uninvaded encapsulated areas.

The encapsulated and calcified areas of necrosis in the diaphyses produced characteristic pictures in roentgenograms.

Uncertainty prevails as to whether the necrosis was produced by nitrogen gas obstruction of end arteries of the bones by embolism or by direct pressure on blood vessels and other tissues after liberation from solution in the fat of the bone marrow or in some other unexplained way. The facts that the long bones of the extremities, which are rich in fatty marrow, were the only bones involved, that fat absorbs relatively very large amounts of nitrogen and that nitrogen bubbles would be absorbed slowly from the marrow tissues because of the known sluggishness of the intra-osseous circulation, favor the theory of direct pressure of the gas on vessels and other tissues within the bone. But the extensive involvement of the diaphyses in some cases without involvement of epiphyses, and the involvement of the epiphyses, especially of the head of the femur, without involvement of



which would favor embolism of the branches of their nutrient arteries. Points against the embolic theory are: (1) The enormous size and symmetrical distribution of the necrotic areas. With such extensive infarction of the bones produced by embolism, similar infarction of the spleen and kidneys might be expected and this was not found at autopsy in Case 1. Also in the presence of such extensive embolism of bones death might be expected to result from embolism of soft parts supplied by end arteries as brain, lungs, kidneys, intestine, etc. (2) Absence of involvement of the bones of the trunk.

In favor of the local pressure on blood vessels and other tissues of nitrogen gas accumulated in the medullary cavities is the limitation of the process to the extremity bones. The extremity bones are rich in fatty marrow while the trunk bones which have higher temperatures than the extremity bones (Huggins and Blockson) contain hematopoietic marrow. Since fats and lipoids are known to absorb approximately five times as much nitrogen as other tissues more nitrogen should be liberated within the extremity bones than within the trunk bones in caisson disease. Bornstein drew attention to the fact that the sluggishness of circulation in the bone marrow would mean less rapid removal of the gas from the bone marrow than from other tissues and consequently greater likelihood of necrosis from prolonged pressure. Larén has shown that when a hydrostatic pressure of 180 centimeters or more is maintained in the medullary canal of the femur of the dog by means of an infusion flask connected with a cannula passing through the cortex massive diaphyseal necrosis of the medullary tissues and the cortex takes place.

Experience in the treatment of aseptic necrosis of the head of the femur in fractures of the neck with bony union Legg Perthes disease and slipped epiphysis indicates that the best possible management of any form of necrosing lesion of the head of the femur (including caisson disease necrosis) is prolonged abstinence from weight bearing thus permitting reorganization of the necrotic area and if possible replacement by new bone with the avoidance of collapse of the head.

#### ANIMAL EXPERIMENTS

A search of the literature on experimental caisson disease failed to reveal a report of examination of the skeleton for evidences of lesions produced by liberated nitrogen gas.

#### Experiments on Dogs

One of us (D B P) in the department of surgery of the University of Chicago attempted to produce bone necrosis on seven dogs by arterial air embolism in the following manner. The dogs were anesthetized with ether and the head lowered in extreme Trendelenburg position. Aseptic technique was used and the right femoral artery was exposed and ligated. An arterial clamp was applied 1 inch above and the artery was opened near the ligature. A uterine catheter, large enough to fill the artery, was introduced and after removal of the clamp pushed upward until its tip was in the aorta just above the bifurcation. Air varying in amounts from 6.7 to 12 cubic centimeters per kilogram body weight was then slowly injected. The air passing into the arteries produced crepitation in the lower extremities. After the wounds were closed the surviving animals were left in the Trendelenburg position for 3 hours to decrease the amount of air embolism in heart, lungs and brain and to prolong that in the lower extremities.

#### Protocols of Experiments

Seven cubic centimeters per kilogram body weight injected in one dog caused paralysis in the hind legs, death in 7 days. The femurs and tibiae were split longitudinally and no gross changes were observed. Microscopic section of upper end of left femur showed no abnormalities.

Eight cubic centimeters per kilogram body weight injected in one dog caused partial paralysis of hind legs. Infection developed in the operative wound and killed the dog in 8 days. Bones of both hind limbs were split open. No gross evidence of necrosis was seen anywhere.

Ten cubic centimeters per kilogram body weight injected in one dog produced partial paralysis in the hind legs which slowly improved to some extent. Death occurred from distemper in 8 days. The bones of the hind legs were removed, reosteographed and split open. A microscopic section was made of the upper end of the femur. No gross or microscopic change was found.

Ten cubic centimeter per kilogram body weight injected into one dog produced complete paralysis.

and contractures of the hind limbs. Animal was sacrificed in 155 days. The spinal cord was examined by Dr. Cloward. It showed marked degeneration in distribution of anterior spinal artery of lumbosacral region. The muscles of the hind limbs were dissected from the skeleton. In places they were pale and shrunken, especially the adductors. Microscopic sections showed extensive-scattered replacement by fat. The bones of the hind limbs were roentgenographed, split open, and the left femoral head was sectioned for microscopic study. No changes were found aside from slight atrophy.

Twelve cubic centimeters per kilogram body weight injected in one dog caused death in 10 minutes from embolism.

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The absence of necrosis in the bones of the 4 dogs whose hind limbs were partly or completely paralyzed by the air embolism may possibly be considered as evidence favoring the view that the bone lesions in caisson disease are due rather to gas liberated in the medullary cavity under sufficient pressure to asphyxiate the tissues than to embolism.

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diaphyses or without continuity of involved regions in epiphyses and diaphyses are points in favor of infarction produced by nitrogen gas embolism or some other form of intravascular obstruction. Experimental air embolism of the lower limbs of dogs failed to produce bone necrosis.

## BIBLIOGRAPHY

- 1 BASSOE PETER Compressed air disease J Nerv & Ment Dis 1911 38 368-369
- 2 Idem Report of Commission on Occupational Diseases of Illinois Chicago 1911 Abstr in J Nerv & Ment Dis June 1911
- 3 Idem The late manifestations of compressed air disease Am J M Sc 1913 145 516
- 4 BERT PALL Compt rend 1871 73 213 503
- 5 BOHR and HENRIQUES Quoted by Stechlin Handbuch der Inneren Medicine Vol 4 (part 2) Berlin J Springer 1917
- 6 BORNSTEIN Versuche ueber die Prophylaxe der Iressluftkrankheit Berl klin Wchnschr 1910 47 1271
- 7 Idem Physiologie und Pathologie des Lebens im Verdichteter Luft Berl klin Wchnschr 1914 51 922
- 8 BORNSTEIN and PLATE L Ueber chronische Gelenkveränderungen entstanden durch Iressluftkrankung Iortschr a d Geb d Roentgenstrahlen 1911-1912 18 107
- 9 BOYCOTT A E DAMANT G C C, and HALDANE J S The prevention of compressed air disease J Hyg 1908 8 342
- 10 BURKHARDT Arthritis Deformans und chr Gelenkerkrankungen 1931
- 11 CHANDLER FREMONT Aseptic necrosis of the head of the femur Wisconsin State M J 1936 35 609
- 12 CHRIST A Ueber caisson krankheit mit besonderer beruecksichtigung einer typischen Erkrankung des Huesfjgelenkes Deutsche Ztschr f Chir 1934 243 137
- 13 HELLER MAGER and SCHROTTER Luftdruckerkrankung Vienna 1900
- 14 HIGGINS C B and BLOCKSON B Changes in outlying bone marrow accompanying a local increase of temperature within physiological limits J Exper Med 1936 64 253
- 15 LARSEN KALPH M Intramedullary pressure with particular reference to massive diaphyseal bone necrosis Ann Surg 1938 108 127
- 16 FREEMSTER D B Fractures of neck of femur dislocations of hip and obscure vascular disturbances producing aseptic necrosis of head of femur Surg Gynec & Obst 1934 50 415
- 17 PLATE ERICH Arthritis Deformans des Huftgelenks entstanden durch Iressluftwirkung nebst Betrachtungen ueber das Zustandekommen solcher Erkrankungen Arch f orthop u unfall Chir 1918 26 201
- 18 TRAYNAM E G A case of caisson disease Prince Alfred Hospital Sydney N S W British M J 1883 1 190-191
- 19 VERNON H M The solubility of air in fats and its relation to caisson disease Lancet 1907 2 691

# THE EARLY DIAGNOSIS OF CERVICAL CARCINOMA

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THE success of the modern treatment of cervical carcinoma largely depends on the early recognition of the disease. The gratifying results of radiation therapy in cases which come under observation in their early stages therefore make early diagnosis of paramount importance. Cancer propaganda alone, which urges the public to seek medical advice as soon as suspicious symptoms appear, cannot be effective because cervical carcinoma in its early stages is symptomless. How long the cancer may be present before it gives rise to symptoms is unknown. The observations of certain gynecologists (Kermauer, Hinselmann, Stahler, and others) that a cervical carcinoma may reach a hopeless stage without producing symptoms, are significant. If it is true that the disease may be in an advanced stage when the first symptoms arise, it is evident that the solution of the problem must involve something more than an appeal to lay women. Nor does more emphasis on the prompt recognition of the early lesion in medical teaching assure definite results. Dietel in Germany studied the histories of a large number of cases of cervical carcinoma and found that in 27 per cent the attending physician was responsible for the delay in treatment, by either failing to recognize the true condition or by neglecting to advise adequate treatment. It is fair to assume that similar conditions prevail in other countries, including this one.

To diagnose a cervical cancer in its symptomless stage may be extremely difficult even for an experienced gynecologist. Carcinoma in its incipency is characterized by minute histological changes, which usually escape recognition, even during the course of a thorough clinical investigation. New diagnostic methods have been perfected in recent years to stimulate interest in the diagnosis of early lesions on the portio. Hinselmann devised a colposcope which permits the visualization of

minute details on the portio. This instrument is a valuable contribution to our diagnostic armamentarium, but has limitations which make its universal use impossible. It is expensive, and its application requires considerable time, experience, and skill, even when used by a specialist. Another new diagnostic method, more generally available, is Schiller's iodine test. This is based on the observation that normal squamous epithelial cells contain glycogen, which stains a dark brown color with iodine. Cancer cells possess an excessive glycolytic activity, and therefore do not take the iodine stain. The corollary of this is that areas which remain uncolored after the application of the iodine solution are suspicious of carcinoma. Experience has proved, however, that the iodine paint is by no means a specific test for cancer. It has been found that certain benign changes on the portio may also show a negative staining reaction, and it has been frequently noted that areas which did not stain on one occasion did so on subsequent tests. This observation seems to indicate that the glycogen content of normal cells is subject to physiological variations, probably due to endocrine influences. Despite the fact that the iodine test is not absolutely diagnostic for carcinoma, its application should be encouraged. It is a simple, harmless procedure, which can be universally adopted by the general practitioner and made a part of every routine examination. Such a practice would serve the purpose of focusing the general practitioner's interest on the portio and cervix, and would increase the number of cases referred to specialists for an early definite diagnosis.

At the present time there is no diagnostic method whereby cervical carcinoma can be recognized invariably in its early, symptomless stage. The epidermoid type of cancer often originates in the transition zone, where the squamous epithelium of the portio merges with the columnar epithelium of the cervical mucosa. This area cannot be visualized by inspection through a speculum. When the

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Fig 1 Photomicrograph of specimen from cervix in Case 1

lesion becomes evident on the portio, a considerable amount of destruction in the cervix has already taken place. The adenocarcinomatous type of cervical neoplasm presents still greater difficulties in early diagnosis. Fortunately this variety occurs rarely, in about 5 per cent of cases. Adenocarcinoma within the cervical canal may reach an advanced stage without initiating symptoms or being recognizable by inspection or palpation. The introduction of a sound into the cervical canal will be of diagnostic value only in fairly advanced cases. The so called central cervical carcinomas, which originate in the deep structures, are hopeless as far as early diagnosis is concerned.

This short review of the diagnostic possibilities in cases of cervical carcinoma demonstrates their relative inadequacy to insure the early recognition of the disease. There is a developmental period in which only a histological examination will reveal the cellular changes which are characteristic of malignancy. Consequently if we hope to make a really early exact diagnosis, biopsy material

must be obtained from cervixes, irrespective of suspicious symptoms.

Three years ago I began a systematic histological study of the cervical mucosa, and my observations were reported in two previous communications (12, 13). In the course of these studies I used two groups of patients. One group consisted of 35 normally menstruating women with apparently normal genitals, and in the histological investigation of the biopsy specimens one case of cervical carcinoma was found, which is reported herewith.

**CASE 1.** A woman 38 years of age came under observation in 1937. She had been married for 15 years, had one child 14, and had had two miscarriages 12 and 3 years previously. She began to menstruate at the age of 14 years, had normal periods thereafter of two to three days duration with moderate flow. Her chief complaint was cramplike pains in the right lower abdominal quadrant for the past 2 days. The region of the appendix was tender. Gynecological examination revealed moderately descended vaginal walls, a perfectly normal looking cervix, a uterus of normal size and consistency, freely movable, and the adnexa were negative. The patient consented to a cervical biopsy, and the cervical mucosa was removed in its entirety on the eighteenth day after her previous menstruation. The histological examination revealed a small area near the external os which was suggestive of carcinoma.

Figure 1 is the photomicrograph taken of this area. The specimen is partially covered by squamous epithelium. At the point of transition into columnar epithelium, epithelial plugs are seen dipping into the underlying stroma. Beneath the surface three islands are seen, which are well defined, surrounded by normal connective tissue. The epithelial cells contained in the islands have hyperchromatic nuclei; some reveal plenty of protoplasm; in others the nuclei fill out the whole cell, indicating irregular mitoses. This histological picture is suggestive of carcinoma, but a definite diagnosis could not be made on the basis of these findings. Serial sections were therefore prepared for a more exacting study. Figure 2 represents the same area in a subsequent section. Several epithelial islands are seen, which consist of cells deeper staining than those found in the covering epithelium. Some cells reveal irregular mitoses and show some variations in their size and shape. At the deepest point from the surface, some of the islands are broken up into small clumps and become mingled with the surrounding inflammatory cell. This picture demonstrates a beginning malignant invasion in the stroma and fulfills all the requirements for the diagnosis of carcinoma. Figure 3 is a photomicrograph of a further section of the same specimen. It visualizes a full blown cervical carcinoma. Near the surface the classical picture of leucoplakia is seen. In the deeper stroma a dense infiltration by small round



Fig 2 Photomicrograph of a subsequent section obtained in Case 1

cells is noted, the epithelial islands are broken up, and there is a deep invasion of the stroma

This case demonstrates a cervical carcinoma in a patient whose genital organs were subjected to a painstaking study and who was found to be gynecologically normal. The carcinomatous lesion was found accidentally in the course of my studies on the normal cervical mucosa. This observation serves as a good example of the problems in early diagnosis. The histological investigation of serial sections permits a tracing of the gradual evolution of the lesion. On and near the surface of the cervical mucosa well defined islands of metaplastic growth were found, and invasion with the earmarks of carcinoma cells was present in the deep tissue, approximately 2 millimeters beneath the surface. It is evident that the development of such a carcinoma requires considerable time before the destructive process reaches the surface, either on the portio or on the endocervix, and becomes grossly visible.

Another group of patients in whom I undertook a systematic histological study of the cer-



Fig 3 Photomicrograph of another later section obtained in Case 1

vical mucosa consisted of 24 cases in which clinical symptoms of endocervicitis and erosion were present, and in which the following case of carcinoma was found:

**CASE 2** A woman 36 years of age came under observation in 1933. At that time she had been married for 14 years and had three children, 9, 7, and 1 years old, respectively. There was no history of abortions. Menstrual periods began at the age of 13 years, recurred regularly every 28 days, were of 4 to 5 days' duration, with profuse flow. Her chief complaint was profuse white leucorrhea and a bearing down sensation. The gynecological examination revealed markedly descended vaginal walls, a lacerated cervix, which was badly eroded, a uterus of normal size, freely movable, and both adnexa negative. On straining a moderate descensus was noted. I advised a diagnostic curettage, conization of the cervix and plastic repair of the pelvic floor, but the patient did not return until 4 years later. Her condition had then become aggravated. The menstrual periods still came at regular intervals, but were prolonged, of 7 to 8 days' duration, and very profuse. The amount of white discharge had increased, and the bearing-down sensation had become painful. On examination, a second degree of cystocele was found. Both lips of the portio were extensively eroded and a



Fig. 4 Photomicrograph of specimen removed in Case 4



Fig. 5 Area adjacent to that in Figure 4

sticky cervical discharge was present. The uterus was moderately enlarged, firm, in good position, adnexa negative. This time the patient consented to an operation.

Under ether anesthesia dilatation and curettage were performed. A large amount of pale endometrial tissue was obtained. Conization of the cervix and plastic repair of the cystocele were done. The histological examination of the endometrial specimen revealed a marked glandular hyperplasia. Similar findings were noted in the cervical specimen but for a small area near the external os where an incipient carcinoma was found.

Figure 4 demonstrates this area. The portio is covered with normal stratified epithelium which abruptly changes at the transition point where there is a loss of layer formation. The epithelial cells are irregular in size and shape and staining reaction. The penetrating epithelium separates the cervical glands in some places; in other areas the glands are pushed together and form regular islands in the strand of epithelium. There are places where one finds nests containing typical spindle cells but having no connection with the surface epithelium. Under high power, irregular mitoses can be seen. This photomicrograph presents the histological picture of an incipient malignancy. An adjacent area to that presented here is visualized in Figure 5. A benign invasion of hyperplastic squamous epithelium into the cervical glands is present. The lumen of the glands

is almost completely filled with epithelial cells, transforming some of them into solid islands. A marked proliferation is present in these islands but they are well demarcated and the individual cells are uniform, not suggesting malignancy. Some of the islands in the deep stroma contain deeper staining cells and occasional irregular mitoses can be seen under high power.

In this case an incipient cervical carcinoma was found, although the clinical picture indicated only a simple erosion with endocervicitis. Both these reported cases of early malignancy have certain features in common which deserve further discussion. In both, the origin of the growth could definitely be placed in the epithelial transition zone. The generally accepted conception, that cervical cancer originates in this area, is supported by these observations. From the viewpoint of early diagnosis this location is unfortunate. The transition point between squamous and columnar epithelium does not correspond with the clinical designation of the external os. Squamous epithelium sometimes extends far upward in the cervical canal, which places the

transition point beyond the reach of inspection. Furthermore, the lesion's tendency is to penetrate into the deep tissues, consequently, the surface of the endocervix and portio remains intact in the very early stages of the disease. Considering all these facts, it becomes evident that there are neither symptoms nor clinical findings on which to base the diagnosis of cervical carcinoma in the early stage.

Another common feature in both cases is the presence of epithelial metaplastic growths side by side with carcinoma. The interpretation of benign epithelial invasions into the cervical mucosa is a controversial matter. Ribbert in his *Textbook of Pathology*, which was published in 1896, discussing cervical carcinomas, stated that benign epithelial metaplasia is the basis on which carcinoma develops through atypical cell divisions. This conception was widely accepted at that time, and among others, von Franke in 1907 considered leucoplasias as precancerous lesions. Subsequent investigators, however, discarded Ribbert's theory. The now generally accepted view was expressed by Robert Meyer, who believes that epithelial metaplasia is the manifestation of a healing process in erosions. The squamous epithelium growing back to the denuded surface, in its proliferation surrounds and invades the ducts of the glands. This invasion may extend to the deeper layer of the mucosa and some glands may be filled out entirely with squamous epithelial cells. Meyer also believes that these invasive growths eventually become displaced to the surface, where they belong, after the healing process is completed. Recently Hinselman, who made an extensive study of leucoplasias, expressed the opinion that carcinoma cannot develop without a preliminary stage such as leucoplacia.

My observations do not seem to substantiate the conception that epithelial metaplasia is a healing process in the cervical mucosa. In 24 cases of marked erosion I subjected the endocervix to a painstaking histological study. In only 3 instances could I find an evidence of epithelial metaplasia in the specimens. If the healing process were the etiologic factor for these benign growths, one would expect the histological picture of epithelial metaplasia to be present in almost every case of erosion.

Recent observations that the biological functions of the cells in the cervical mucosa are under hormonal influences, a fact clearly demonstrated in my previous studies, place the interpretation of metaplastic growths on a new basis. In animal experimentations it has been shown by several investigators (Selye, Thompson and Collip, Overholser and Allen; Engle and Smith, and others) that prolonged administration of follicular hormones exerts a specific stimulation on the epithelial cells of the cervical mucosa. Herold and Effkeman experimented with rats. After the administration of follicular hormones, they observed the crowding out of the normal columnar epithelial linings of the glands by squamous epithelium. After 3 months' treatment some glands were found to be entirely filled with squamous epithelium and conveyed the impression of isolated islands beneath the surface. In castrated rats the epithelial metaplasia occurred after a shorter period of treatment than in normal animals.

In a castrated woman I followed up the histological changes in the cervical mucosa during the administration of estrone, and observed changes in the human cervix identical with those reported in animals. I was able to produce epithelial metaplasia in the human endocervix by prolonged hormone administration, and the disappearance of the metaplastic growths was noted after discontinuance of the hormone therapy. A detailed report of my observations in this case will be made at a later date.

Data are accumulating which prove that epithelial metaplasia in the cervical mucosa is the result of excessive hormonal stimulation. It is of interest to ascertain in the case herein reported whether the histological picture of the endometrial specimen substantiates this contention. We know that excessive follicular hormone production is expressed in the endometrial histology by the production of hyperplasia. An endometrial specimen (Fig 6) was obtained in Case 2, which case incidentally revealed the most pronounced metaplastic changes in the cervical mucosa. The photomicrograph shows the typical picture of glandular hyperplasia. Portions of the cervical mucosa outside the areas of carcinoma reveal





Fig 4 Photomicrograph of specimen removed in Case 2



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apparently removed all of the malignant growth

#### IMPORTANCE OF EARLY DIAGNOSIS, METHODS OF OBTAINING BIOPSY SPECIMENS

An early diagnosis of cervical carcinoma is of twofold importance. Of prime importance are the clinical considerations, because early cases yield to irradiation therapy in a gratifying manner, and a cure can be anticipated in a majority of them. There are indications to warrant the hope that in incipient cases a radical excision of the cervical mucosa alone may eradicate the neoplastic process. A case may be regarded as incipient so long as it remains symptomless and clinically unrecognizable, although the diagnosis may be made from histological findings. From a clinical standpoint, it is highly desirable that cervical carcinoma shall be detected and extirpated in its incipency.

The other factor which makes an early diagnosis of paramount importance is the scientific aspect of the problem. We cannot hope to solve the cancer problem without acquiring exact knowledge of the histological genesis of carcinoma in the human. At the present time there is no clean cut histological definition of carcinoma. Some pathologists consider variations in the size, shape, and staining qualities of the epithelial cells and atypical mitotic figures as carcinomatous, while others are reluctant to make a definite diagnosis of carcinoma unless malignant invasion into the stroma is present. Whether carcinoma is the result of gradual changes in the biological function of the cells is a moot question. It is difficult to draw a sharp line of demarcation between a benign atypical epithelial proliferation and carcinoma. It is logical to assume, however, that if the histological study of a sufficiently large number of incipient cases were possible these questions might be solved eventually. The uterine cervix is an ideal site for such an investigation, as it is easily accessible and permits the taking of biopsies without serious discomfort and unpleasant sequelæ to the patient.

It is unfortunate that the diagnostic histological exploration of the cervical mucosa has not had the attention it deserves. This is particularly true because this structure is the

most common site of pathological lesions in the female genital tract. Ninety per cent of uterine carcinomas originate in the cervix. Furthermore, in gynecological practice a normal looking cervix is unusual. Considering these facts, it seems reasonable that the endocervix as a histological unit should receive as much attention as the uterine lining membrane, the endometrium. In the many routine diagnostic curettages the endocervix is hardly, if ever, touched. It must be remembered that a simple scraping of the endocervix with a curette does not provide sufficient tissue for a histological diagnosis. As I pointed out in my previous studies, due to the peculiar anatomical structure of the cervical mucosa, adequate tissue material can be obtained only by excision. For this purpose I have employed the Hyams' conization method (5) during the past 5 years in nearly two hundred cases, and have never observed any untoward after-effects. If conization is done after dilatation and curettage, it does not add to the discomfort of the patient and does not prolong hospitalization. Routine removal of the cervical mucosa for histological examination should be regarded as a logical procedure in cases in which a diagnostic curettage is indicated.

Cervical pathology is not necessarily manifested by symptoms which would indicate a diagnostic curettage. It has been shown by my 2 cases that the most destructive lesion of all, carcinoma, may develop in a symptomless cervix. The limited number of extremely early cases reported elsewhere in the literature were also found accidentally. Evidently, if a beginning cervical carcinoma is to be discovered in any large number of cases, a routine procedure must be adopted in office gynecology, which permits the taking of cervical biopsies, irrespective of the absence of suspicious symptoms. A method is available, which by its simplicity and safety deserves to be included in our diagnostic armamentarium. For diagnostic purposes it is not necessary to remove the cervical mucosa throughout its entire length, since sufficient observations have proved that cervical carcinoma originates in the lower half of the canal. No early case has been found in the literature to indicate a higher point of origin. I designed cutting wires for coning out



Fig 6 An endometrial specimen Case 2



Fig 7 Cervical specimen showing markedly dilated glands with preserved epithelial lining

histological changes similar to those found in the endometrium. Figure 7 visualizes the cervical specimen in which numerous markedly dilated glands with well preserved epithelial lining are seen. The picture very much resembles that found in hyperplastic endometria, called the 'Swiss cheese pattern'. The histological study of both the endometrial and cervical specimens reveals changes which are known to be the result of excessive estrone influence.

In the histological diagnosis of early cervical carcinomas epithelial metaplasia merits special attention. Whenever such a benign epithelial invasion is discovered, it is advisable to subject the specimen to a thorough study by making serial sections. In my 2 cases a gradual transformation of benign epithelial hypertrophy into malignancy was noted. There is a strong indication that epithelial metaplasia developing under hormonal influence constitutes the basis on which carcinoma originates because of the added stimulus. There really is little difference between carcinoma cells and the normal epithelium. The difference lies

chiefly in an altered biological activity, manifested by rapid proliferation. We know that estrone governs the normal proliferation of the epithelial cells and that its continuous action produces benign epithelial invasions into the glands which invasion however is orderly never penetrating into the surrounding stroma. The factor which adds the stimulus for unorganized destructive, invasive growths has not yet been found.

The clinical course of my 2 reported cases deserves to be mentioned. After having established the diagnosis of carcinoma, no further treatment was given these patients. Both of them are regularly reporting for a gynecological follow up. The first patient has now been observed for 24 months and the second for 22 months, since the diagnosis of carcinoma was established. Both patients are well, and repeated careful examinations fail to reveal any sign of a lesion in the genital tract. The elapsed time is too short to justify a final opinion but the implications are that the simple radical excision of the cervical mucosa

# EARLY PHASES OF PROSTATIC HYPERPLASIA

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**M**ANY theories have been proposed by men interested in the various branches of medicine to explain the development of benign prostatic enlargement in man. An extensive study of the gross and microscopic lesions has been made, but insufficient attention has been given to the early phases of the enlargement. The urologist frequently observes that the benign enlargement of the prostatic gland, which he sees at operation, is covered by a thin layer of posterior urethral epithelium. In many instances, the tumor seems to replace most of the prostatic gland. There is full agreement with regard to the histological constituents of the surgical specimens. They are composed of glandular, fibrous, and muscular tissues, but the relative amounts of these tissues are variable. The fact that there is a preponderance of the glandular tissue has led investigators to presuppose that the enlargements are mainly glandular in origin. The wide distribution of the glandular nodules in the various lobes of the prostate is further evidence in support of this theory. One of the outstanding declamations is that of Marion and Zuckerkandl, who believed that these enlargements begin in the glands of Albarran Velpéau, as early as 1841, recognized fibromuscular masses. Thompson, in 1873, was inclined to believe that the primary tumors bear some resemblance to early uterine myomas. As late as 1929, Kausch, in Germany, suggested that the glandular elements are derived from the deep urethral glands. Keyes, Hinman, and Randall adduce evidence from the material studied to show that most of the foregoing theories of early development of "prostatic hypertrophy" are justifiable.

It is necessary to have more definite knowledge concerning the early anatomical phases of benign prostatic enlargement before its

cause can be logically established. It is the object of this paper to attempt to throw more light on the first and foremost part of the problem, namely, the beginnings of the so called prostatic hypertrophy. In the prostatic glands which we see at the operating table, so much disorientation of the components of the organ has been produced by growth, pressure, and atrophy that little information is to be obtained from a study of them. The basis for consideration of the early anatomical lesions of the so called prostatic hypertrophy is the study of anatomical specimens of prostates obtained at autopsy from subjects 45 years of age and upward. From the microscopic study of minute, early lesions one can hope to show where and how the lesion originates.

The specimens were fixed in 10 per cent formalin solution and cut transversely at five different levels. When small nodules were discovered, either with the naked eye or by microscopic study, serial sections were cut of the entire transverse section involved, and the nodule or nodules were followed up and down the prostate to their terminations. Various stains were used, but the hematoxylin-eosin and Masson trichrome stains have proved the most satisfactory, the latter being employed to differentiate muscle from fibrous tissue. The large and complete sections were first studied by throwing the entire section on the screen with the projectoscope. This gave an opportunity for comprehensive study of the architecture of the gland as a whole which it is impossible to obtain by the use of the microscope. For minute, localized detail of the sections, the microscope played its part.

From 150 specimens, 24 prostates with sufficiently early lesions have been studied. The specimens contain aglandular and glandular areas in various stages of development. In most of the specimens the two lesions exist together, in 6 only aglandular masses are found, in none of the specimens do glandular nodules exist without aglandular areas.

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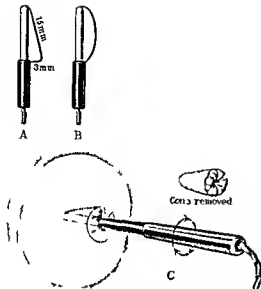


Fig 8 A wire used in nulliparæ B in lacerated cervixes C instrument in application

the lower half of the endocervix, which differ from the Hyams conization wires in their size and shape. They are three quarters of an inch long and are constructed in two different shapes. Figure 8 depicts the electrodes. A the wire used in nulliparæ and B in lacerated cervixes, whereas C shows the motion by which the specimen is obtained. Employing this method the area near the internal os is avoided, thereby causing less discomfort to the patient, as this region is the most sensitive part of the cervical canal. The circular excision is completed in a few seconds and can be done without anesthesia. The excised specimen is placed in formalin solution for subsequent histological study. The denuded area does not require after treatments, and re-epithelialization is complete after 3 weeks, without scar tissue formation or subsequent stenosis.

#### SUMMARY

The present study is based on 59 cases in which a routine removal of the cervical mucosa was done for purposes of a systematic histological investigation. Although none of these

cases revealed symptoms or clinical findings which indicated malignancy, in 2 patients definite cervical carcinoma was found. In both cases a simple excision of the endocervix apparently effected a cure. My experiences justify the following recommendations: (1) No diagnostic curettage should be considered complete without removal and histological examination of the cervical mucosa. After dilatation and curettage the Hyams conization offers the simplest and safest way to accomplish this purpose. (2) Every woman past her thirtieth year should be considered a potential candidate for cervical carcinoma. It is advisable for patients in this age group to have at least one routine tissue examination of the lower half of the cervical mucosa. The only contraindication for this procedure is inflammation or tenderness in the adnexa.

I believe that in the present cancer-conscious era it should not be difficult to impress our patients with the advantages of a routine cervical biopsy. Gynecologists who adopt these two recommendations, may be rewarded by the gratifying experience of recognizing and curing an occasional patient with incipient cervical carcinoma. The accumulating histological studies on the lower half of the cervical canal will contribute greatly to a better understanding of the physiological function of a structure which is a common site of carcinoma.

#### REFERENCES

1. DIEZEL. Deutsche med. Wchnschr. 1935 13 698
2. ENGLE and SMITH. Anat. Record 1935 61 471
3. HEROLD and EFFKEMAN. Zentralbl. f. Gynaek. 193 61 77
4. HENSELMAN. Veit's Handbuch der Gynaekologie—Stoeckel. Vol. 6 part 1 p. 874. Munich J. F. Bergmann 1930
5. HYAMS. Am. J. Obst. & Gynec. 1933 5 653
6. KERMAUNER. Biologie und Pathologie des Weibes—Halban and Seitz. Vol. 4 p. 69. Berlin Urban & Schwarzenberg 1928
7. MEYER. R. Handb. d. spez. path. Anatomie u. Histologie 1930 7 165
8. OVERHOLSER and ALLEN. Proc. Soc. Exper. Biol. & Med. 1933 30 1322
9. RIBBERT. Lehrbuch d. Pathologie u. Histologie. Bonn 1896
10. STABLER. Arch. f. Gynaek. 1933 153 561
11. SELVE THOMPSON and COLLIP. Nature 1935 135 65
12. WOLLNER. Surg. Gynec. & Obst. 1937 64 758
13. Idem. Am. J. Gynec. & Obst. 1938 36 10



Fig 4 Photomicrograph of prostate Fibromuscular nodule with budding duct branches adjacent to the nodule but external to capsule, C Note epithelial proliferation on duct wall adjacent to nodule and relative inactivity on its opposite wall  $\times 42\frac{1}{2}$



Fig 5 Same as Figure 4, 100 microns distant

duct These epithelial buds may enter the solid nodule laterally or centripetally and form glands Because the glands grow more rapidly than the muscle and collagenous tissue, they may entirely replace the muscle tissue and cause the nodule to appear wholly glandular As the peripheral muscle tissue becomes compressed, it forms the "surgical capsule" of the glandular mass This method of glandular tissue formation from ducts is similar to that seen in the normal embryological budding from the posterior urethra, which forms the anlage of the prostatic glands This process may be a re-awakening of the activity possessed by these ducts during the embryological period One can readily demonstrate this epithelial response on the inside of a duct adjacent to an aglandular nodule, while directly across its lumen the epithelium is dormant (Figs 4 and 5)

In this study, glandular nodules have not been found in the lateral and posterior lobes of the prostate Aglandular nodules have been seen in the roof of the urethra and below the crista urethralis, from which hyperplastic lobes could theoretically develop The ante-

rior and middle hyperplastic lobes have not been studied, nor have we found the reason for the occurrence of an isolated glandular lobule within the bladder at some distance from the prostate and not connected with it A continuation of these studies should undoubtedly reveal these mysteries

Since the glandular component of the prostatic hyperplasia is seen to be derived from the prostatic ducts within the urethral muscular wall, one would like to analyze further the origin of the aglandular nodules The fibromuscular nodules of the prostate resemble histologically the fibromyomas of the uterus (Fig 6) The uterine tumor has been shown to develop from a muscle cell The sinus utricularis is the homologue of the uterus and hence of muellerian duct origin The work of Lowsley, Walker, and others on the embryology of the prostate and urethra discloses the fact that the muscle fibers of the lower muellerian duct system meet the muscle fibers of the wolffian duct system in the posterior urethra and intertwine themselves with the muscles which come down from the ureters, trigone, and bladder The largest number of solid muscular nodules is found near the utricle and below its floor (Fig 7) The aglandular, fibromuscular tumors

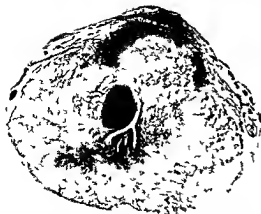


Fig 1 Photomicrograph of prostate of man aged 72 years. Section near verumontanum showing fibromuscular nodule near urethra.  $\times 2$

The aglandular areas are found within the musculature of the urethral wall. They may be single (Fig 1) but are more often multiple and bilateral, located anywhere within the musculature of the urethral wall between the external and internal sphincters. As they develop in size, they tend to become round and oblong in shape and may later become quite large and encapsulated. As the result of localized outgrowths or of the union of two or more of the developing centers, they may assume a nodular appearance. That these aglandular nodules develop to a size sufficient

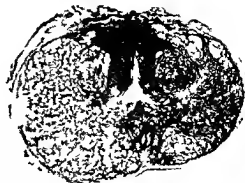


Fig 2 Photomicrograph of prostate of man aged 68 years showing glandular nodule in lateral portion of muscular urethral wall. Glandular nodule in lateral portion of muscular urethral wall. Glandular nodule contains heavy muscular stroma.  $\times 1\frac{1}{2}$

to cause urinary obstruction has been well demonstrated by Hinman and Sullivan, Mitchell and Blaisdell, and Vescen. In the routine histological examination of surgical prostatic specimens, it is not uncommon to find masses of solid tissue and even definite encapsulated aglandular nodules in the presence of glandular nodules. Patch and Rhea found that 25.4 per cent of 181 consecutive surgical specimens of so called prostatic hypertrophy showed leiomyomatous nodules varying in size from 0.5 to 3.0 millimeters.

The glandular nodules vary in size and are surrounded by circular muscle fibers (Fig 2). The acini within a nodule may show active budding projections and dilated cystic areas. Cystic dilatations may appear early, but corpora amylacea are not seen in the early lesions. The glandular nodules are found in the muscular wall of the urethra (Fig 3) and have not been seen in the lateral and posterior lobes. When these nodules increase in size they deflect the urethra greatly, compress the true lateral and posterior lobes, and appear as lateral lobes on either side of the urethra. They apparently do not develop from the suburethral glands of Albarran, as was formerly thought.

The study of serial sections has led the authors to believe that the glandular nodules are a result of the invasion of an aglandular nodule by epithelial buds from an adjacent



Fig 3 Photomicrograph of prostate of man aged 74 years showing bilateral tumors. A a fibromuscular nodule half invaded by glands. B a small glandular nodule on opposite side.  $\times 1\frac{1}{2}$

in dogs and rats As far as the authors are aware, no one has ever demonstrated a pathological benign prostatic enlargement in dog, rodent, monkey, or horse which caused retention of urine, nor has such a lesion been produced experimentally in animals All of the experimentally produced prostatic enlargements are physiological hypertrophies, not tumors or hyperplasias We must not confuse them with the pathological lesion in man The natural prostatic enlargement in the old dog compares histologically with the experimental enlargement produced by testicular hormonal injections It can be reduced by removal of the testicular hormone or by castration of the dog Castration in man has failed to show any effect on the pathological prostatic enlargement The fact that benign pathological enlargement of the prostate has been found in eunuchs leads one to minimize the part played by the testicle in its development

Rothschild, Greene, and Brooks believed prostatic enlargement to be the result of inflammation, as suggested by Ciechanowski, but Cabot and Smith have clearly demonstrated that men with histories of infection are less likely to develop a "prostatic hypertrophy" Prostatic enlargement is not due to arteriosclerotic changes, because it occurs in individuals who do not have arteriosclerosis Reischauer's theory of compensatory hypertrophy is illogical Kausch has correctly ruled out the adenoma theory, because the growth does not fulfill the criteria enunciated for adenomas We have shown that the enlargement does not begin in glands, nor is it necessarily derived from glands If it were derived from the musculature around a duct or gland, the primary nodule would show a duct or gland within its center This has not been shown in our observations

#### SUMMARY

This work definitely discloses that the early change of benign enlargement of the prostate in man is primarily a multiplication of fibromuscular elements It resembles in its early stages the uterine fibromyoma, which is derived from a muscle cell of the uterus Since the posterior urethra and the internal vesical

sphincter contain muscle fibers which are derived from the same embryological building material as that of the uterus, it is fair to assume that these two tumors have the same origin We do not agree wholly with Adrion that the glandular portion of the tumor is necessarily derived from glands but believe that it has its origin in ducts adjacent to the fibromyomatous nodule The suburethral glands of Albarran are not involved in early lesions It is probable that the solid nodule produces some stimulating and proliferating effect upon the epithelium of the duct wall, causing the epithelium to invade the solid nodule and form glands within it The fibromyomatous tissue is invaded and overgrown by a more rapidly growing duct and glandular tissue, with the result that the nodule in its later stages develops the appearance of an encapsulated glandular tumor Benign prostatic enlargements are not hypertrophies but are true hyperplasias, derived from muscle, fibrous tissue, and ducts

Recognition is made of the assistance of Dr. Dan S. Egbert and of Dr. Hyman A. Weiner in the early part of this study Appreciation is also expressed to Mrs. Ethel Kober for the preparation and mounting of the histological sections

The greater part of this work was made possible by an anonymous gift and by a grant from the Fluid Research Fund of Yale University

#### REFERENCES

1. ADRIAN, WALTER Ein Beitrag zur Aetiologie der Prostatahypertrophie Beitr z path Anat u z allg Path, 1922, 70 179-202
2. CABOT, HUGH, and SMITH, GEORGE G The influence of structure of the urethra on the development of hypertrophic changes in the prostate Lancet-Clinic, 1912, 107 456-465
3. CIECHANOWSKI, S Anatomische Untersuchungen ueber die sogenannte Prostatahypertrophie und verwandte Prozesse Mitt a d Grenzgeb d Med u Chir, 1901, 7 183-332
4. GREENE, R H, and BROOKS, H The nature of prostatic hypertrophy J Am M. Ass, 1902, 35 1051-1059
5. HINMAN, FRANK The Principles and Practice of Urology Philadelphia W B Saunders Co, 1935
6. HINMAN, FRANK, and SULLIVAN, JOHN H Two cases of leiomyoma of the prostate J Urol, 1931, 26 475
7. HIRSCH, E W Pathology of prostatic hypertrophy J Urol, 1936, 35 227-234
8. KAUSCH, H Die Prostatahypertrophie Frankfurt Ztschr f Path, 1929, 38 333-361
9. KEYES, EDWARD L, and FERGUSON, RUSSELL S Urology 6th ed New York D Appleton-Century Co 1936
10. LOWER, W E Endocrine influence on male sex organs New England J Med, 1933, 208 878-886



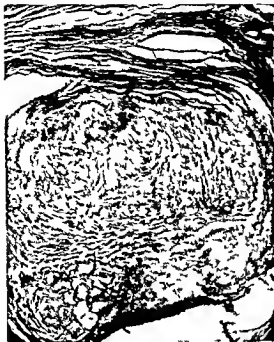


Fig 6 Photomicrograph of prostate of man aged 67 years showing fibromyomatous nodule. Note capsule few glands in one side and definite whorl of muscle fibers resembling uterine myoma  $\times 40$

develop around small blood vessels which increase in number with the growth and nourish it (Fig 8). Whether the nodule remains fibromuscular or is transformed into a glandular

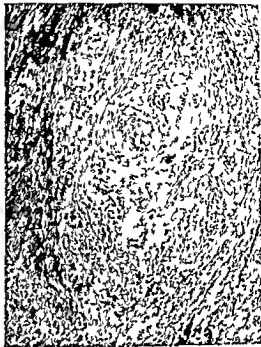


Fig 8 Photomicrograph of prostate. Early fibromyomatous nodule forming around vessels  $\times 41$

nodule depends on whether or not the primary nodule is invaded by the epithelium of an adjacent duct.

Further evidence to support the hypothesis that these tumors of the prostate arise from the vestigial component of the muellerian system may be elicited from a consideration of activity produced in homologous vestigial organs by hormones. In the dog all the prostatic glands are derived from the epithelium of the utricle, which is very sensitive to estrin (Zuckerman). In rodents and the rhesus monkey part of the glands of the prostate take their origin from the urethral buds and part from the sinus epithelium, while in man all of the prostatic glands have been shown to originate from urethral epithelial buds. Further study along this line should add materially to the practical issues involved in tissue reactions to hormones.

Our present knowledge of these specific reactions, although limited, is supported by Lower and his co-workers, who have produced a physiological hypertrophy of the prostate



Fig 7 Photomicrograph of prostate of man aged 64 years. Note small light areas below floor of urethra representing early fibromuscular nodules. Three glandular nodules are also present  $\times 203$

of the band the muscle arises from the of the ischium; but as far as can be mined by palpation only the three or posterior fascicles actually arise from the

The band as a whole can be readily ted almost throughout its length from acent margin of the coccygeus muscle. rtion is entirely bony, no fibers enter ls of the pelvic organs

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#### AL DIAPHRAGM

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The urogenital diaphragm (triangular liga- ment) as a whole, situated below and in front of the pelvic diaphragm, completes the pelvic support; arising from the inferior ischiopubic rami, this musculomembranous shelf stretches across the anterior one third of the pelvic out- let at a right angle to the long axis of the vaginal canal The muscles of the urogenital diaphragm constitute the external sphincter of the urethra in the male, but in the female they are also closely related to the vagina and the urethra The muscle fibers course chiefly in a transverse direction, toward the midline Encountering the tubular organs, they insert firmly into their walls (Fig 3)

As described, bilateral bands of muscle bun- dles ascend, wing-like, upon the urethra, clothed by the superior fascial layer of the diaphragm Between the urethra and the vagina only a slight interval exists, through which a few fibers of the sphincter interdig- itate with those from the opposite side of the urneum The bulk of the muscle fibers of so called sphincter of the urethra actually mates in the wall of the vagina, as does -culature of the levator ani The space the vagina and the rectum is again that fibers can scarcely be traced dline at that point The most ed muscle fibers of the urneum do not terminate as mu

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ter muscle ich termina- thra, which continue transverse oblique



Fig 6 Photomicrograph of prostate of man aged 67 years showing fibromyomatous nodule. Note capsule. Few glands in one side and definite whirl of muscle fibers resembling uterine myoma.  $\times 45$

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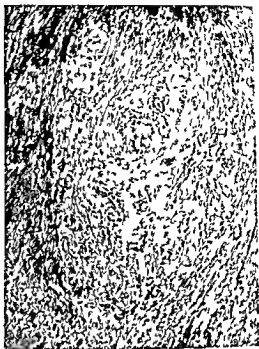


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Our present knowledge of these specific reactions, although limited, is supported by Lower and his co-workers, who have produced a physiological hypertrophy of the prostate

# THE ANATOMY OF THE PELVIC AND UROGENITAL DIAPHRAGMS, IN RELATION TO URETHROCELE AND CYSTOCELE

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**I**N the course of a re-study of the female pelvis and perineum, certain controversial anatomical features of gynecological importance remained undetermined after our concerted attack from the combined viewpoints of the anatomist and the gynecologist, despite painstaking dissection of the pelvis of five selected female bodies, a sixth dissection, this time from within the pelvis, displayed the anatomical relationships so effectively that we are impelled to present our observations and clinical deductions<sup>1</sup> The three accompanying illustrations by Tom Jones are life-size<sup>2</sup> drawings made from the actual dissections

## PERITONEUM AND EXTRAPERITONEAL (CELLULAR) TISSUE

Within the pelvis of the present specimen, and in the manner regularly described, the parietal peritoneum of the abdominal cavity proper is carried downward into the pelvic subdivision of the cavity, where it is draped over the contained viscera, adapting itself to the inequalities produced by them<sup>3</sup> This peritoneum is at an appreciably higher level than the parietal fascia which covers the pelvic floor (the superior fascia of the pelvic diaphragm) There is thus created a considerable

subserous space between the peritoneum and the fascia, this is filled with an adipose areolar tissue, through which course the visceral nerves and vessels<sup>4</sup>

The features of anatomy described are corroborative of those found in the usual descriptions of the female pelvis With them the present study is not particularly concerned, our interest being centered in the diaphragmatic structures upon which the pelvic organs rest, and their tubular reflections, which, ascending upon the organs, form strong musculo-fibrous investments

## ENDOPELVIC FASCIA

A firm fascia covers the pelvic floor, this is the superior fascia of the pelvic diaphragm (Fig 1), the endopelvic fascia is that portion which is reflected from the floor upward upon the viscera The manner of reflection for the bladder is different from that for the rectum and vagina (Fig 1) An aponeuroticofascial ridge sweeps forward from the region of the spine of the ischium, and soon divides into an inferior fascial arch, the white line, and the somewhat more superiorly placed, slightly curved arcuate ligament. At the lateral wall of the bladder the fascial arch (the white line) is a wing-like elevation standing away from the pelvic wall, the abundant cellular tissue is easily removable from it Each wing divides to pass in front of and behind the bladder, thus forming a fascial tube for that organ The urethra is covered anteriorly with the endopelvic fascia, but laterally, the fascia is stretched from the pelvic wall to the bladder above the level of the urethra

The fascial tubes of the endopelvic fascia for the vagina and the rectum are reflected

From the Department of Obstetrics and Gynecology and the Department of Anatomy (contribution no 277), Northwestern University Medical School Presented, in part, at the San Francisco meeting of the American Medical Association (J Am M Ass, 1938, 111 903)

<sup>1</sup>The subject was a negress, 20 years of age, 5 feet 3 inches tall, weight 72 pounds (after embalming) The pelvis and perineum were completely free from gross pathology, the arteries were unusually well injected It is the authors' belief that such a report upon serial dissections of a completely normal subject should be helpful to the gynecologist, stylized portrayals are common conventionalized descriptions thereof equally abundant It is planned to extend this study as rapidly as suitable specimens become available

<sup>2</sup>The plates have been reduced to five-eighths actual size

<sup>3</sup>Compare Figs 86 to 89, 94 to 96, in Anson, B J, Anatomy of the female genitalia and pelvic soft parts, Chapter I, and Obstetrics and Gynecology, edited by Arthur H Curtis, Philadelphia W B Saunders Co, 1933

<sup>4</sup>Figs 12 and 13, in Curtis' Textbook of Gynecology, 3d ed Philadelphia W B Saunders Co, 1938

- 11 Idem The prostatic problem J Urol 1937 37 555-556
- 12 LOWER W I FAGEL W J and McCULLACH D R Summary of experimental research on control of benign prostatic hypertrophy and preliminary clinical report J Urol 1935 34 670-677
- 13 LOWER W L and HICKEN, N J Experimental research by parabiosis showing hypophyseal gonadal influence on growth and development of prostate gland J Urol 1932 28 601-606
- 14 LOWSLEY OSWALD S The development of the human prostate gland with reference to the development of other structures at the neck of the urinary bladder Am J Anat 1912 13 297-340
- 15 MARTON G Hypertrophie de la Prostate L'encycl franc d urol Vol 6 Librairie Octave Doin 1923
- 16 MITCHELL D K and PLAINBELL J L Leiomyoma of the prostate Brit J Urol 1933 5 331
- 17 PATCH I S and RHEA L J Leiomyoma of the prostate gland Brit J Urol 1935 7 213-228
- 18 RANDALL A Surgical Pathology of Prostatic Obstructions Baltimore Williams & Wilkins Co 1931
- 19 REICHMEIER F Ueber die formale Genese der organischen Prostatihypertrophie Beitr z klin Chir 1934 167 460-483
- 20 ROTHSCHILD A Ueber die Frage der aetologischen Beziehungen zwischen Gonorrhoe und Prostatihypertrophie Centralblatt f d Krankh d Harn u Sex Org 1904 15 177-190
- 21 TANDLER J, and ZICKERMAN O Studien zur Anatomie und Klinik der Prostatihypertrophie Berlin Julius Springer 1922
- 22 THOMPSON H The Diseases of the Prostate Their Pathology and Treatment Comprising the Jacksonian Prize Essay for the Year 1800 4th ed Philadelphia H C Lea 1815
- 23 VERHAU Leçon Orales de Clin Chir Paris 1841 3 478 Cited by Crandon L K C The pathogenesis and pathological anatomy of enlarged prostate Ann Surg 1902 36 846
- 24 VESSEY I J Fibromuscular hyperplasia of the prostate J Urol 1929 22 30
- 25 WALKER GEORGE A contribution to the study of the anatomy and physiology of the prostate gland and a few observations on the phenomenon of ejaculation Johns Hopkins Hosp Bull 1900 No 115 242-256
- 26 ZICKERMAN S and GROOMY J R The etiology of benign enlargement of the prostate in the dog J Anat & Pathol 1931 44 113-124

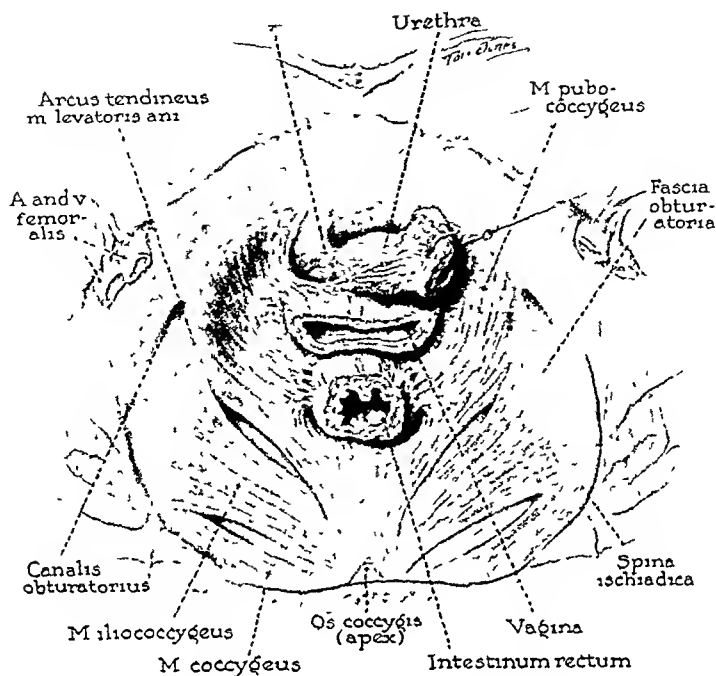


Fig 2 The fascial layers illustrated in Figure 1 have been removed and the viscera excised to a lower level, in order to demonstrate the muscular constituents of the pelvic floor and the relations of these to the viscera. The urethra has been pulled aside to show the course of the levator fibers on its posterior aspect and the nature of the "pubourethral ligament," indicated by an astensk

upper border is arching, convex on its superior edge, this line of attachment coinciding at the summit of the convexity with the edge of the obturator foramen at the position of the obturator canal

This anterior portion of the levator ani inserts not only into the coccyx but also into the urethra, the vagina, and the rectum, the rectal portion is broadest, the vaginal insertion is two-thirds as wide as the rectal, and but few fibers enter the urethra, these upon its posterolateral aspect

The fibers of the muscle which pass to the vagina ascend for a short distance upon the vagina, then lose themselves in the intrinsic musculature of the organ

These important visceral relations of the pubococcygeal muscle are neglected features in the textbooks of anatomy which students and practitioners customarily consult, no mention has heretofore been made of the rela-

tions of the muscle bundles to the urethra, that which has been offered regarding their relation to the vagina and the rectum is incorrect

Thus, Gray (1936) states that the pubococcygeus is directed backward along the side of the anal canal on the way to a coccygeal attachment; according to Cunningham (1937) the medial part of this muscle (termed puborectalis) sweeps backward over the side of the vagina and the rectum, the muscles of the two sides meeting dorsally to form a sling for the anorectal junction. This concept is repeated in Morris (1933), the statement being made that the fiber bundles course past the urogenital organs and the rectum on each side. According to Spalteholz (1930) a few fibers are sent into the wall of the rectum, Piersol (1930) similarly describes an insertion of pubococcygeal fibers into the lower part of the rectum.



tion of the band the muscle arises from the spine of the ischium, but as far as can be determined by palpation only the three or four posterior fascicles actually arise from the bone. The band as a whole can be readily separated almost throughout its length from the adjacent margin of the coccygeus muscle. Its insertion is entirely bony; no fibers enter the walls of the pelvic organs.

3 *Coccygeus* (Figs 2 and 3) The plane of the flat surface of the coccygeus lies at almost right angles to that of the iliococcygeus.<sup>1</sup> In the region of the ischial spine the separate fascicles are very evident, but medially the surface is smooth and tendinous rather than muscular. The muscle at its coccygeal insertion is excessively thin. It is aponeurotic at its insertion, and almost entirely aponeurotic along its posterior margin.

#### THE UROGENITAL DIAPHRAGM

The superior fascia of the urogenital diaphragm, in relation to the urethra, is not a smooth plane, being elevated at the lateral margins of the urethra to a height of 0.8 centimeter above the floor proper (Fig. 2). This paired structure is a miniature counterpart of the uterosacral ligaments. Arising from the pubic bone it forms bilateral bands which narrow somewhat, then spread out upon reaching the urethral wall. Posteriorly, in ascending from the pelvic floor, they are smooth, but anteriorly they are set off from the pelvic floor and elevated in the form of wing-like margins. Together the wings, which might well be called *pu o-urethral ligaments*, bound a tiny cul-de-sac through which the perineal veins communicate with the pelvic venous plexus (removed in the dissections), this cul-de-sac, oval in outline, is 1.5 centimeters wide, 0.8 centimeter long (with the urethra retracted

posteriorly). These ligamentous wings correspond in position to the transverse ligament of the pelvis but they are more than simply the fused fascial layers of the urogenital diaphragm, since within each is included a band of muscle fibers. They ascend on the lateral walls of the urethra for a distance of 0.6 cm., the skeletal fibers becoming lost among those of its intrinsic musculature (Fig. 3).<sup>2</sup> Here, again, as in the relationships of the levator to the organs, current descriptions have been found to be inadequate.

The urogenital diaphragm (triangular ligament) as a whole, situated below and in front of the pelvic diaphragm, completes the pelvic support, arising from the inferior ischiopubic ramus, this musculomembranous shelf stretches across the anterior one third of the pelvic outlet at a right angle to the long axis of the vaginal canal. The muscles of the urogenital diaphragm constitute the external sphincter of the urethra in the male, but in the female they are also closely related to the vagina and the urethra. The muscle fibers course chiefly in a transverse direction, toward the midline. Encountering the tubular organs, they insert firmly into their walls (Fig. 3).

As described, bilateral bands of muscle bundles ascend, wing-like, upon the urethra, clothed by the superior fascial layer of the diaphragm. Between the urethra and the vagina only a slight interval exists, through which a few fibers of the sphincter interdigitate with those from the opposite side of the perineum. The bulk of the muscle fibers of the so called sphincter of the urethra actually terminates in the wall of the vagina, as does the musculature of the levator ani. The space between the vagina and the rectum is again so narrow that fibers can scarcely be traced across the midline at that point. The most posteriorly placed muscle fibers of the urogenital diaphragm do not terminate as muscle fascicles in the wall of the rectum, rather it would seem that there are aponeurotic extensions to the rectum of those muscle fibers

<sup>1</sup>The coccygeus muscle is 2.4 centimeters wide at its origin, 4.0 centimeters in width at the insertion, at this extremity the aponeurosis attaching the muscle to coccyx is exceedingly thin, measuring slightly less than 0.1 centimeter in thickness. Since the only important difference structurally between the iliococcygeus and the coccygeus is in the character of the origin, the present terminology would seem to be illogical. While one muscle arises principally from tendon and the other from bone, both insert into the coccyx or coccygeus, as it now is (since its tendinous origin is iliac), whereas the latter should be called ischio-coccygeus, because its insertion sets it off from the other two portions, it really should be included with them as one of the constituents of the pelvic diaphragm. The fact that the coccyx is wide proximally and therefore fills a greater portion of the pelvic opening should make no difference in the scheme of naming these two muscles. So far as can be judged from the specimen, the origin of the coccygeus takes place from the very margin of the ischium just above the spine and from the posterior border of the spine itself.

<sup>2</sup>That part of the urethral sphincter muscle which ends in the vagina is 1.3 centimeters wide, that which terminates in the urethra is exactly half that width. The pelvic urethra, which would correspond to the prostatic portion of the male, is 2.5 centimeters in length. The urethra measures 1.4 centimeters in the transverse direction, 0.8 centimeter in the sagittal. It is apparent from probing its lumen that an appreciable dilatation occurs between the internal meatus and the level of the urogenital diaphragm.



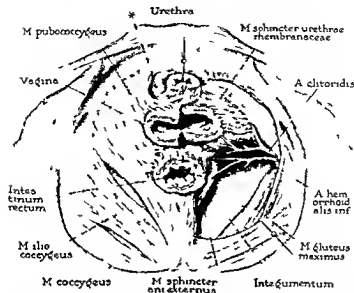


Fig 3. The musculature of the left side remains the same as in Figure 2. The urethra has been cut down to within 1.4 centimeters of the urogenital diaphragm. The right half of the vagina has been cut to a level corresponding to that of the superior surface of the urogenital diaphragm; on the left it remains as in the preceding figure. On the right the pubococcygeal portion of the pelvic diaphragm has been removed and the ilio coccygeal portion has been retracted to show the gluteus maximus muscle. From the ischioanal fossa all of the fatty tissue has been removed to expose the inner surface of the perineal integument. The musculature of the urogenital diaphragm (the urethral sphincter) is revealed by the removal of the superior fascia; additionally the pudendal artery and its branches are shown as they pass from Alcock's canal to the viscera and urogenital diaphragm; the veins have been excised.

It is evident from the foregoing that no standard work on anatomy presents a description of pelvic structure which meets the requirements of present day gynecology.

As in the case with the vaginal part, the muscle fibers of the rectal subdivision of the pubococcygeus are lost in the intrinsic coat; the small muscle bundles became tendinous and insinuate themselves into the space between the longitudinal and circular coats of intrinsic musculature there interdigitating with the fibers of smooth muscle. Between these interdigitating muscle bundles there occur definite hiatuses through which pass small hemorrhoidal vessels; with the unaided eye at least five of these can be seen (vessels have been removed in the dissections so that only spaces are seen in Figs. 2 and 3).

The part of the entire pubococcygeus which inserts chiefly into the coccyx resembles a true

subdivision, since between it and that portion which terminates in the rectal wall a cleft exists along two thirds the length of the adjacent margin—the cleft interrupted midway by an exchange of muscle fibers across the hiatus. The cleft is prominent at its medial end, since there it is bounded posteriorly by fibers which pass to a deeper part of the rectum. The insertion of the hinder part is covered by a ligamentous band which takes the place of the expected rectococcygeus muscle.

**2. Iliococcygeus.** This posterior or iliac part of the levator ani at its origin is chiefly tendinous (Figs. 2 and 3).<sup>1</sup> The border is concave superiorly; the combined origin of the ilio coccygeus and pubococcygeus describing an S shaped curve. At the extreme posterior por-

<sup>1</sup>The ilio coccygeus muscle is 3.3 cm. in width at its origin; it tapers to 1.5 cm. at its coccygeal end; (of which approximately 0.8 cm. is inserted into the coccyx by the pubococcygeus).

tion of the band the muscle arises from the spine of the ischium; but as far as can be determined by palpation only the three or four posterior fascicles actually arise from the bone. The band as a whole can be readily separated almost throughout its length from the adjacent margin of the coccygeus muscle. Its insertion is entirely bony, no fibers enter the walls of the pelvic organs.

3 *Coccygeus* (Figs 2 and 3) The plane of the flat surface of the coccygeus lies at almost right angles to that of the iliococcygeus<sup>1</sup>. In the region of the ischial spine the separate fascicles are very evident, but medially the surface is smooth and tendinous rather than muscular. The muscle at its coccygeal insertion is excessively thin. It is aponeurotic at its insertion, and almost entirely aponeurotic along its posterior margin.

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<sup>1</sup>The coccygeus muscle is 2.4 centimeters wide at its origin, 4.0 centimeters in width at the insertion, at this extremity the aponeurosis attaching the muscle to coccyx is exceedingly thin, measuring slightly less than 0.1 centimeter in thickness. Since the only important difference structurally between the iliococcygeus and the coccygeus is in the character of the origin, the present terminology would seem to be illogical. While one muscle arises principally from tendon and the other from bone, both insert into the coccyx or coccyx and sacrum. It would seem that the former should be termed iliococcygeus, as it now is (since its tendinous origin is iliac), whereas the latter should be called ischio-coccygeus, because its insertion sets it off from the other two portions; it really should be included with them as one of the constituents of the pelvic diaphragm. The fact that the coccyx is wide proximally and therefore fills a greater portion of the pelvic opening should make no difference in the scheme of naming these two muscles. So far as can be judged from the specimen, the origin of the coccygeus takes place from the very margin of the ischium just above the spine and from the posterior border of the spine itself.

posteriorly). These ligamentous wings correspond in position to the transverse ligament of the pelvis but they are more than simply the fused fascial layers of the urogenital diaphragm, since within each is included a band of muscle fibers. They ascend on the lateral walls of the urethra for a distance of 0.6 cm., the skeletal fibers becoming lost among those of its intrinsic musculature (Fig 3)<sup>2</sup>. Here, again, as in the relationships of the levator to the organs, current descriptions have been found to be inadequate.

The urogenital diaphragm (triangular ligament) as a whole, situated below and in front of the pelvic diaphragm, completes the pelvic support, arising from the inferior ischiopubic ramus, this musculomembranous shelf stretches across the anterior one third of the pelvic outlet at a right angle to the long axis of the vaginal canal. The muscles of the urogenital diaphragm constitute the external sphincter of the urethra in the male, but in the female they are also closely related to the vagina and the urethra. The muscle fibers course chiefly in a transverse direction, toward the midline. Encountering the tubular organs, they insert firmly into their walls (Fig 3).

As described, bilateral bands of muscle bundles ascend, wing-like, upon the urethra, clothed by the superior fascial layer of the diaphragm. Between the urethra and the vagina only a slight interval exists, through which a few fibers of the sphincter interdigitate with those from the opposite side of the perineum. The bulk of the muscle fibers of the so called sphincter of the urethra actually terminates in the wall of the vagina, as does the musculature of the levator ani. The space between the vagina and the rectum is again so narrow that fibers can scarcely be traced across the midline at that point. The most posteriorly placed muscle fibers of the urogenital diaphragm do not terminate as muscle fascicles in the wall of the rectum, rather it would seem that there are aponeurotic extensions to the rectum of those muscle fibers

<sup>2</sup>That part of the urethral sphincter muscle which ends in the vagina is 1.3 centimeters wide, that which terminates in the urethra is exactly half that width. The pelvic urethra, which would correspond to the prostatic portion of the male, is 2.5 centimeters in length. The urethra measures 1.4 centimeters in the transverse direction, 0.8 centimeter in the sagittal. It is apparent from probing its lumen that an appreciable dilatation occurs between the internal meatus and the level of the urogenital diaphragm.

which are contributed to the perineal body. They affect only the anterior third of the rectal wall, the remaining posterior two thirds of the rectum receives fibers only from the pelvic diaphragm.

#### ISCHIORECTAL FOSSA

Just inferior to the line of attachment of the combined origin of the pubococcygeal portion of the levator ani muscle and superior to the bony origin of the urogenital diaphragm next below, is situated the obturator fascia, as it forms the lateral wall of the anterior recess of the ischiorectal fossa (Fig 3). Medially, near the viscera, this recess is a mere cleft, along the line of fusion of the muscles and investing fascias of the urogenital and pelvic diaphragms. Its roof is the pubococcygeal portion of the levator ani (retracted in Fig 3 to reveal the posterior recess of the same fossa). Its floor is the gluteus maximus muscle. Crossing this space are the vessels which will be described hereinafter. At the medial limit of the fossa is the external sphincter muscle of the anus.<sup>1</sup>

At the anterior limit of both diaphragms their layers virtually meet, the cleft between the levator ani and the subjacent superior fascia of the urogenital diaphragm being a very slight one.<sup>2</sup> It will be recalled that at this anterior point the urogenital diaphragm

is elevated locally to form bands which we have chosen to name the "pubo urethral ligaments."

#### BLOOD VESSELS

**Arteries** From the internal pudendal artery two vessels are given off, the posterior one to structures in the anal triangle, the anterior to those in the urogenital (Fig 3). The posterior stem is the inferior hemorrhoidal artery which sends branches to the anal canal and, enroute several to the fatty tissue in the fossa. The anterior stem divides into two branches, from the lunder one of the two, twigs are given off to the musculature in the two compartments; one twig, the perineal artery, pierces the base of the superficial compartment. The forward branch, like the others, courses anteriorly, remaining near the lateral wall of the anterior recess in the substance of the urogenital diaphragm, therein it gives off muscular branches and sends twigs to the vagina.<sup>3</sup> The main stem continues forward as the clitoral artery. **Veins** The veins in general follow, in plexiform manner the arterial stems.

#### LITERATURE CITED

1. ANSON, B. J. *Anatomy of the female genitalia etc*. Chapter I. Obstetrics and Gynecology. Edited by Arthur H. Curtis. Philadelphia: W. B. Saunders Co. 1933.
2. CUNNINGHAM, S. *Text book of Anatomy*. Edited by J. C. Brash and E. B. Jamieson. 7th ed. New York: Oxford University Press. 1937.
3. CURTIS, A. H. *Textbook of Gynecology*. 3d ed. Philadelphia: W. B. Saunders Co. 1938.
4. GRAY, HENRY. *Anatomy of the Human Body*. Edited by W. H. Lewis. 3d ed. Philadelphia: Lea & Febiger. 1936.
5. MORRIS, Human Anatomy. Edited by C. M. Jackson. 9th ed. Philadelphia: J. B. Lippincott & Co. 1933.
6. PIERCE, Herman. *Anatomy*. Revised by G. C. Huber. 9th ed. Philadelphia: J. B. Lippincott Co. 1930.
7. SPALTERHOLZ, W. *Hand Atlas of Human Anatomy*. Edited by L. F. Barker. 3d Eng. ed. Philadelphia: J. B. Lippincott Co.

<sup>1</sup>The vertical depth of the external anal sphincter is 2.3 centimeters. While anteriorly the two diaphragms, pelvic and urogenital, are in contact posteriorly—at the lateral limit of the space between them—are separated by a distance of 1.40 centimeters. Medially, at the lateral limit of the ischiorectal fossa, this corresponds to the posterior limit of the pubococcygeus muscle. Laterally, the distance of 2.0 centimeters intervenes between the line of origin of the muscle and the inferior margin of the rectal tuberosity. The urogenital diaphragm is 3.0 centimeters thick (measured to paracantal plane). At its lateral limit, to the rectum, the urethra, vein and duct return from obturator foramen to the inferior limit of the urethra. At the posterior margin of the urethra, the corresponding ureters (1.5 centimeters) pass through the clitoris between the urethra and vagina. At its posterior margin, the diaphragm is 0.6 centimeters wide (this line passes between the rectum and vagina). The thickness of the diaphragm posteriorly is 3 to 4 millimeters (the thickness of the anterior portion of the pelvic diaphragm is 2.5 millimeters). In comparison with the thickness of the posterior margin of the coccygeus (2.5 millimeters).

<sup>2</sup>The rectum referred to in Fig. 3 is the rectum. Textbook of Gynecology, 3d ed. which is shown from actual dissection. The rectum of vagina branches of the blood artery.

## EARLY SURGERY IN BILIARY DISEASE

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**S**TATISTICS from the large medical clinics in this country show that biliary disease is the most frequent single cause of indigestion, and that 60 per cent of the complaints made to the physician are referred to the gastro-intestinal tract. Expressed differently it can be safely stated that 15 per cent of the population of the United States suffers from biliary disease. This figure increases to 30 per cent after the age of 45 years. In the past the diagnosis was made entirely upon clinical findings and history and consequently many cases were missed until the extracystic complications of jaundice, pancreatitis, cholangitis, etc., showed the true state of affairs. Today, however, there is but little excuse for overlooking biliary disease. Eighty per cent of our own diagnostic failures have been due to inability, through linguistic difficulties, to obtain a satisfactory history. We never operate on dye evidence alone. The use of the x-ray, the dye test, biliary drainage and a careful history should, and has, resulted in earlier and more frequent diagnosis and also in establishing in people's minds the fact that indigestion, gas, dyspepsia, eructations, etc., are merely symptoms of a disease that requires surgery to establish a cure. And yet vital statistics of the insurance companies show that the nation's mortality from this condition is just as high as it was 24 years ago, despite early and better diagnosis and we hope better surgery with vastly improved pre-operative and postoperative care. There is but one answer—and that is delay in the proper surgical treatment while unjustified medical treatment is continued. Medical treatment is rarely, if ever, justified for symptoms producing calculi with or without complications. It is to be remembered that silent gall stones do exist. These rarely if ever require protective surgery but all others do require both protective and corrective surgery. The patient, the physician, and even the surgeon have been all too prone in the past to

procrastinate. Surgery practised early in the disease and early in the acute attack has produced a remarkable reduction in morbidity and mortality.

### ACUTE CHOLECYSTITIS

At the moment the management of acute cholecystitis is the most controversial topic in connection with the surgery of the gall bladder. Surgeons of outstanding ability are divided in their opinion as to whether it is best to operate on these cases immediately or after the acute attack has subsided. The arguments for immediate operation are that the complications of empyema, gangrene, and perforation occur in acute cholecystitis as they do in acute appendicitis, that these complications frequently are not recognized since the severity of the clinical symptoms does not run parallel to the pathological changes in the gall bladder, that the mortality due to these complications offsets any reduction in mortality which may accrue from delaying the operation, and finally that the patient is spared needless pain. The arguments for delay are that the analogy between acute cholecystitis and acute appendicitis is not valid in that gangrene and perforation are not as likely to occur in the gall bladder as in the appendix, that even if perforation does take place there is a far greater probability of the resulting peritonitis being localized by adhesions, that the gravity of any operation on the gall bladder requires that the general condition of the patient be as favorable as possible, and that the edema of the gall bladder wall during the acute phase makes operation unduly hazardous. In the surgical literature of the past few years the voices of those who favor immediate operation have been raised more loudly than those holding to a conservative viewpoint. This has upset completely the formerly accepted opinion that operation should be withheld until the acute process "cools off." Miller, after having two

patients die from perforation during the period of expectancy, reviewed a series of 200 cases from the Massachusetts General Hospital and observed that in the fatal cases the period from the onset of acute symptoms to operation averaged 15 days, while in those who recovered it was 8.3 days. Zininger noted that of the patients whose operation was delayed only 37 per cent improved, 35 per cent showed no significant change, and 27 per cent became definitely worse. Stone contends that the tendency to perforation and spreading peritonitis from acute cholecystitis differs only in degree and not in principle from the course of acute appendicitis or perforating ulcer and that the patients who are going to become worse with delay require prompt operation, while those in whom the symptoms would subside do just as well with early surgery. Judd and Phillips noted an incidence of the complications of gangrene and perforation in 13.4 per cent of cases of acute cholecystitis. They subscribe to the plan of early operation with reservations, believing that in certain cases it is wiser to postpone the operation for a long time and that there can be no set plan for dealing with this disease.

Smith, influenced by his experience at St. Luke's Hospital in New York, feels that immediate operation should not be done without urgent indication and, particularly in the older patients and the poor risks, if the course is favorable under observation, it is wiser to wait for 'cooling off'. Heuer is emphatic about the desirability of early operation pointing out in a review of cases from the New York Hospital that the incidence of extracholecystic abscess in acute cholecystitis is 10.5 per cent as compared with a 17.5 per cent incidence of perforation in acute appendicitis. In Heuer's series, all of whom were operated upon promptly, the operative mortality was only 2.1 per cent unless perforation had occurred prior to operation in which case it was 12.5 per cent. Taylor places the operative mortality at 5 per cent if operation is done during the first 4 days of the attack and at 24 per cent thereafter but adds that no case is so urgent that pre-operative administration of adequate amounts of glucose can be neglected.

Confusion has arisen due to the failure of many advocates of early surgery to state clearly

- 1 Whether immediate operation means an emergency procedure done within an hour or two of the onset of the illness or after the patient's admission to the hospital, or one done after complete studies can be made to assess the patient's condition and the time allowed for the required pre-operative preparations to be carried out,

- 2 Whether cholecystectomy is done as a routine procedure or the operation adapted to the findings,

- 3 Whether the incidence of the late complications of biliary fistula and strictures of the ducts following the removal of acutely inflamed edematous gall bladders has increased therefrom.

*Preliminary treatment.* In cases with a positive or proved diagnosis seen during the first few hours of an attack, morphia hypodermically should be given at once and everything withheld by mouth. Fluids, preferably glucose 5 per cent in salt solution, is given by venoclysis. Operation is undertaken as soon as the necessary general medical survey can be carried out, the frequent coexistence of diabetes and myocarditis with biliary disease being kept in mind. At this stage the absence of edema permits the ideal cholecystectomy to be performed as a rule. Those patients who have been ill 24 to 36 hours without adequate treatment are also best managed by morphia, venoclysis, and starvation for 12 to 18 hours. If after this period any one symptom fails to subside, operation is done. Similarly patients admitted after 24 or more hours, who are still ill despite proper treatment, i.e., morphia and the withholding of everything by mouth, should have prompt operation. It has been our experience that in patients who have had acute obstructive gall bladder disease for 7 or more days the symptoms will not as a rule subside completely under any treatment except surgery; hence further delay is dangerous and useless. In all three groups the procedure may be either cholecystostomy or cholecystectomy depending upon the local conditions which govern safe surgery such as induration or edema around the ducts obscuring the

anatomy, pancreatitis, jaundice, perforation, etc

When this expectant mode of treatment is adopted and the patient's course is favorable, operation may be deferred until the temperature has been normal at least a week, and the local tenderness has entirely disappeared. Flint points out that usually some pericholecystitis accompanies acute inflammation of the gall bladder and that operation done too soon may result in the spreading of this infection. Furthermore the surgeon is frequently surprised at the amount of residual edema and lymphatic adenopathy found in cases which have apparently subsided. This increases the technical difficulties of the operation and also the hazard of injuring one of the ducts. The pathological state of the gall bladder cannot be safely estimated by any physical or laboratory tests—hence the danger of delay. Not infrequently the problem will arise of persuading a patient to have the operation when he or she seems to have recovered. Such patients are courting certain trouble, and the necessity for operation should be insisted upon.

In determining upon the operation to be done, the crux of this problem lies in the recognition not only of the fact that acute cholecystitis demands early surgical intervention but that the operation must be suited to the conditions of acute local infection. Accordingly the procedure which may be ideal from the standpoint of ultimate morbidity may have to be modified for the sake of immediate mortality. Cholecystectomy is a better operation than cholecystostomy but the latter may frequently be safer and more prudent in the presence of acute inflammation. The rule must be observed absolutely that cholecystectomy should never be done unless the relationships of the hepatic, cystic, and common duct and the cystic artery can be clearly visualized by the surgeon. Granting that in all cases cholecystectomy is more satisfactory from the standpoint of ultimate results, the indications for cholecystostomy may be stated as follows. (1) when the condition of the local tissues militates against safe removal of the gall bladder, (2) when the physical difficulties of obesity, uneven anesthesia, poor illumination or inadequate assistance make proper ex-

posure impossible; (3) when serious local complications, such as jaundice, pancreatitis, or carcinoma call for drainage only, (4) when age or serious renal cardiovascular or pulmonary complications indicate that surgical intervention should be simple and expeditious. The safety of the patient is greatly enhanced if the surgeon will recognize not only his own but the limitations of his patient, and stops with a cholecystostomy rather than attempting too much at one operation.

#### CHRONIC CHOLECYSTITIS

Surgical treatment is indicated in most cases of chronic cholecystitis with or without stones provided the diagnosis is reached after careful investigation which excludes other possible sources of pain or indigestion. The laboratory findings must not be overemphasized in making this diagnosis unless they are in agreement with the clinical history. The roentgenologic demonstration of gall stones does not necessarily imply that these are responsible for the patient's symptoms, since silent stones are frequently carried for many years. It is for this reason that every effort must be made to exclude extrabiliary causes before subjecting the patient to surgery for failure to do so may result in disappointment to both patient and surgeon. Medical treatment is justifiable so long as it gives uninterrupted relief. There is a tendency in this as in other diseases of a chronic and not completely incapacitating nature to procrastinate before submitting to a major surgical procedure. It must be remembered that not only do the risks and the technical difficulties of biliary surgery increase with delay but after the infection has extended to adjacent organs removal of the gall bladder cannot be expected to cure the patient. Graham aptly illustrates the peril of procrastination by citing operative mortality figures for cholecystectomy. If done after two attacks it is 2 to 3 per cent, after three or more attacks, 8 to 9 per cent, in the presence of jaundice, 10 to 12 per cent, and with pancreatitis it is 50 per cent. Mason estimates that about one third of his patients are relieved by a medical regimen; the others either submit to operation after a few years or should do so but refuse.

The results of surgery in cholelithiasis are better than in non calculous cholecystitis. This may be due in part at least to the greater accuracy of diagnosis when history of typical colic is elicited. Cholecystectomy likewise gives better results than cholecystostomy. The former is the operation of choice provided the surgeon is able to visualize clearly the relationships of the cystic, hepatic, and common ducts and the cystic artery and provided the condition of the patient warrants the performance of the more extensive operation. There are instances in aged or poor risk individuals when simple removal of stones and drainage of the gall bladder is wiser than cholecystectomy.

Electrocardiographic studies are desirable but myocardial disease should not contraindicate gall bladder surgery. There is increasing evidence that removal of the gall bladder may improve the cardiac condition, particularly in patients with arrhythmias. Provided these cardiac patients are compensating or can be restored to compensation by bed rest and digitals, they present no more serious surgical risk than do those with normal hearts.

Infection of the bile by the bacilli of typhoid fever is an indication for cholecystectomy. These typhoid carriers present a public health menace through the periodic discharge of organisms into the intestinal tract. This source of infection can be eradicated only by removal of the gall bladder. Coller and Forsbeck report 88 per cent of cures in a series of 16 typhoid carriers operated upon and recommend that carriers who are under the age of 50 be subjected to cholecystectomy whether or not they show clinical evidence of cholecystitis. In the older patients the risk of operation is greater and discretion must be used by advising operation only when the usual indications exist.

*Operative technique—Cholecystostomy* Infiltration anesthesia with procaine may be used in bad risk patients in which the simplest form of operation is to be done. Whenever circumstances permit, spinal or inhalation anesthesia is preferable since it gives more adequate exposure and enables the surgeon to do a more satisfactory operation.

The incision may be through the upper right rectus, an approach which is far from ideal anatomically but gives good exposure or it may be an oblique subcostal one in which the muscles are split in the direction of their fibers at the outer border of the rectus and sufficient of the rectus fibers divided transversely to give access to the gall bladder. The latter spares more of the nerves supplying the rectus abdominis and thereby diminishes the danger of subsequent incisional hernia. The paramedian incision is preferred by some but in males at least the gall bladder is apt to be so far laterally as to be reached with difficulty by an approach which is so near the midline. The placing of the drain presents difficulties in this incision also although it may be brought out through a lateral stab wound.

Our preference is for the subcostal approach, the line of skin incision being one finger breadth below the costal margin and parallel with it. When the muscles are split, a finger is inserted into the peritoneal cavity and then several sutures are taken through both sheaths of the rectus down to the subperitoneal layer. These sutures prevent retraction of the muscle within the cut edges of its sheath and facilitate closure without a dead space. The incision may be extended across the midline if desired by opening the falciform ligament. Upon opening the abdomen in every case, but especially when dealing with acute inflammation, the surgeon should carefully isolate the gall bladder by gauze packs before it is opened. When the organ is tensely distended, aspiration with a syringe and hollow needle will facilitate the necessary manipulations. The gall bladder is then grasped with Allis clamps and opened at the fundus. An aspirating device with a large blunt tip should be at hand. Stones may be removed with the aid of a scoop or frequently they can be grasped with a curved hemostat. Stones impacted in the ampulla or in the cystic duct are often difficult to dislodge. However, the whole object of the operation is missed unless all stones are removed. The senior author and L. K. Ferguson have devised a cholecystoscope which is on the order of a short sigmoidoscope and carries a light at the tip. This is a great aid in visualizing the inaccessible portions of the gall bladder. When all

tones have been removed, clear bile may enter the gall bladder although often the edema about the cystic duct prevents its immediate appearance. A catgut suture should be placed through the edges of the gall-bladder wall transfixing a rubber tube. Then when a purse-string suture is placed and drawn taut, pushing of the tube downward into the gall bladder will help to invert the edges of its wall around the tube. Usually a second purse-string suture will be required to ensure a snug fit around the tube. If there is gross contamination, a soft cigarette drain should be placed alongside of the gall bladder before the wound is closed. As the skin sutures are placed and before the dressings are applied, the cholecystostomy tube should be securely anchored to the abdominal skin by two long narrow strips of adhesive tape, which in turn pass through a safety pin attached to the tube by means of a silk ligature surrounding it. We have had trouble with tubes being pulled out prematurely because they were not securely fastened in place, or because the adhesive anchorage was not renewed every 4 or 5 days. The tube should be promptly connected with a drainage bottle slung at the side of the bed and a record kept of the amount of material which drains into it. This should be included on the output side in the daily calculation of fluid balance. The usual cholecystostomy tube remains in place for from 10 to 14 days although in certain instances prolonged drainage may be desirable. Cholecystostomy, although a stop gap procedure in many instances, has resulted in cures in approximately 65 per cent of the patients upon whom we have employed it. It is our impression, although not checked, that the wounds in these cases compare favorably with the cholecystectomies as far as herniation occurrence.

*Cholecystectomy.* From the technical standpoint considerable muscular relaxation is essential for proper exposure. Nitrous oxide and oxygen alone will not provide this in most cases even with an expert anesthetist. Cyclopropane or ethylene may do so. Ether by open drop or in combination with other gaseous agents is the most dependable of the inhalation methods. Due to the characteristic short necked, wide chested configuration

of many patients with gall-bladder disease, the endotracheal technique of administration of inhalation agents is often of great aid in insuring an unobstructed airway and controlling the depth of anesthesia. Local infiltration with novocain has been espoused by some enthusiasts but requires considerable skill and much patience. Splanchnic block has never been in great favor in this country and possesses no great advantages over spinal anesthesia. The latter is highly satisfactory for upper abdominal surgery although it must be employed with discretion due to its inherent dangers. The choice among the various suitable methods of anesthesia must be made with due regard to the particular requirements of the individual patient.

Subcostal oblique or right upper rectus incisions, as described for cholecystostomy, are used.

*Operative technique.* The operation should begin with an exploration which includes not only the biliary system but the stomach, duodenum, pancreas, appendix, and colon. The surgeon then knows how much must be done and is not embarrassed by the tardy discovery of unsuspected lesions at a time when the patient has had all the surgery that he can stand. The intestines are packed off and exposure obtained by the use of two or at most three retractors. One retracts the duodenum downward, the second draws the falciform ligament toward the left and the third may be required to elevate the lower surface of the liver. There is more than one way of removing a gall bladder, but we prefer first to identify the cystic duct and its relation to the hepatic and common ducts, ligate it, and the cystic artery and then proceed with the dissection of the gall bladder from its bed, beginning at the ampulla. This enables the operator to visualize clearly these structures by reason of the dry field and permits the accomplishment of the difficult and precarious portion of the operation with the best visibility. Beaver has pointed out that the textbook description of the relations of the biliary ducts obtains in only 58 per cent of the cases. In 26 per cent the hepatic and cystic duct run parallel to one another and the former may be injured if care is not exercised. Accessory ducts are present



in 87 per cent, the most common anomaly being an accessory right hepatic duct arising from the cystic. Ligation of this may be fatal and leaving it open will result in biliary fistula. The first step in removal is to elevate the gall bladder by placing a clamp on its ampulla, then to split the peritoneal coat over the ampulla of the gall bladder and expose the ducts. Gauze dissection will aid in exposing the cystic duct although hemorrhage may be encountered from the small veins lying anterior to it. It is helpful to remember that the veins in the plexus over the cystic duct lie parallel with it whereas over the common duct they form a network. If exposure is inadequate at this point, it is sometimes helpful to aid in the rotation of the liver by placing a gauze pack over its dome. Using a ligature carrier or a curved hemostat, two strands of No. 1 chromic catgut are passed around the duct and the latter is doubly ligated close to its juncture with the common hepatic duct. A clamp is then placed on the duct between the bladder and the ligatures to prevent spilling of bile and the duct is divided. The stump may be cauterized with phenol and the ligature nearest the common duct cut short. The other ligature should be left long as a guide until the surgeon is ready to close the wound. The cystic artery can usually be palpated even though not seen at this point and should be brought into view and ligated close to the gall bladder since it sometimes has a branch running to the right lobe of the liver. The remainder of the operation is usually not difficult unless the gall bladder is deeply buried in the liver. As the serosal reflections are divided the gall bladder comes away from its bed. Hemorrhage is controlled by placing a few interrupted sutures of No. 0 catgut through the cut edges of the peritoneal coat. An infected gall bladder bed should not be closely sutured. Venous ooze from the under surface of the liver can often be checked if a small bit of muscle is cut from the edge of the incision and placed against the liver surface making gentle pressure against it for several minutes. The gall bladder should not be completely severed from the liver until all bleeding is under control since as soon as this is done the liver retracts upward under the costal

margin. We routinely place a soft cigarette drain in the fossa above the duodenum bringing it out on the lateral angle of the wound. We have never had cause to regret this procedure. Not infrequently bile stained drainage material for several days makes the surgeon thankful that the wound was not tightly closed. Advocates of non drainage appear on the horizon now and then only to meet catastrophes sooner or later that make them return to the use of drainage. Moynihan once said that "as I grow older a wee bit of a drain in these cases makes me sleep better." The wound is closed in layers, a continuous row of No. 1 chromic catgut sutures being used for the peritoneum and interrupted sutures of fine alloy steel in the aponeurosis of the muscles. The skin is closed with the same steel alloy. The drain may be removed on the second or third day if the progress is entirely satisfactory. Cholecystectomy performed for gall bladder disease uncomplicated by common duct disease, pancreatitis etc., has given us 94 per cent cures.

#### COMMON DUCT OBSTRUCTION

Obstruction of the common duct whether from calculus, stricture, neoplasm of the duct itself, or the compression of an extrinsic mass will produce the characteristic manifestation of jaundice. Since the most common cause, common duct stone, is amenable to surgical relief, and the other causes may be relieved if not cured, most patients with common duct obstruction should be given the benefit of operative exploration. Hemolytic icterus and intrahepatic biliary obstruction should be excluded by laboratory tests of which the Van den Bergh bromsulphthalein and blood fragility tests are the most significant. Estimation of the degree of jaundice is of importance and whereas the hue of the skin and the color of the stools serve as a rough guide, a determination of the icteric index is more accurate. When the obstruction is due to a progressive lesion such as stricture or neoplasm, the jaundice also is progressive and relentless. With common duct stone there are usually periods during which some bile flows into the duodenum and the jaundice accordingly lessens intermittently. Patients with common duct

obstruction present serious risks for surgery because there is coincident liver damage and also because of the hemorrhagic tendencies inherent to jaundice. The time for operation must be chosen with discretion. As a general rule it is inadvisable to operate while the jaundice is increasing unless it is obvious that a desperate chance must be taken. On the other hand, when the jaundice is clearing, it is well to wait for the maximum improvement. If the level of jaundice reaches a peak and levels off, nothing is gained by further delay.

Prior to operation the ordinary fluid and nutritional requirements must be met and special measures must be instituted. We know that the livers of jaundiced patients are deficient in glycogen and infiltrated with fat. The administration of glucose is imperative because it serves as a source of energy which can be easily metabolized and this obviates further depletion of liver glycogen. In addition to its value from the metabolic standpoint, glucose exerts a favorable effect upon blood coagulation reducing the tendency to hemorrhage. Many patients are able to take sufficient quantities by mouth in the form of sweet fruit juices or hard candy. The oral route should always be used when available; otherwise glucose may be given intravenously. The other important anticoagulant measure is the transfusion of blood. Small amounts (100 c cm) given repeatedly are of great value. In the presence of anemia larger transfusions should be employed since reduction in red corpuscles greatly increases the operative risk. Calcium has had a vogue as an anticoagulant although there never has been adduced definite evidence that reduction in serum calcium is associated with delayed blood coagulation or that clotting is favorably influenced by the administration of the calcium salts. We place no reliance upon it.

The anesthetic agent and the method used must avoid damage to liver cells or disturbance in the blood sugar level. At the same time it must provide sufficient muscular relaxation for adequate deep exposure. Aside from the necrotizing effect on liver cells of such an agent as chloroform, the damage to the liver from an anesthetic is that of the associated anoxemia. Nitrous oxide, avertin,

or the barbiturates are poorly suited since to maintain surgical anesthesia the concentration of oxygen in the respiratory exchange is reduced to a dangerously low level. More potent anesthetic gases, such as ethylene or cyclopropane, permit the addition of larger proportions of oxygen and are more desirable from this standpoint at least. Ether is accompanied by some reduction in oxygen capacity and content and has a disturbing effect upon blood sugar. Nevertheless its obvious advantages are recognized and it may be used with impunity in cases of early or mild disease of the liver. Local infiltration with novocain usually fails to provide the exposure required by the surgeon. Spinal anesthesia obviates this defect and also the undesirable toxic effects. There may be contraindications to the use of spinal anesthesia from the standpoint of the cardiovascular mechanism and in such cases resort may well be to ethylene or cyclopropane provided the skilled anesthetist required for their use is available.

*Operations* The problems of preparation for operation, choice of anesthesia and post-operative care, are common to all cases of surgical jaundice regardless of its cause. The operative procedure will vary, depending upon the cause of the obstruction of the duct. At this point certain general principles concerned with obstruction of the common duct by stone will be dealt with. In the presence of strictures of the ducts or of malignancy the procedure is covered in the discussion of these subjects.

It frequently happens that the diagnosis of an obstruction of the common duct is not obvious before operation and at the moment jaundice is absent. In such cases, the surgeon must have certain criteria for opening and exploring the duct. The favorable statistics from large clinics to the contrary, there is no doubt that in average hands the morbidity and mortality will be increased by this procedure over that which will follow surgery confined to the gall bladder. Exploration of the duct should not be done as a routine but it ought not to be omitted (1) when there is a history of jaundice, hepatic fever, acholic stools, etc., (2) when a stone can be palpated in the duct even though there has been no jaundice;

in 87 per cent, the most common anomaly being an accessory right hepatic duct arising from the cystic. Ligation of this may be fatal and leaving it open will result in biliary fistula. The first step in removal is to elevate the gall bladder by placing a clamp on its ampulla, then to split the peritoneal coat over the ampulla of the gall bladder and expose the ducts. Gauze dissection will aid in exposing the cystic duct although hemorrhage may be encountered from the small veins lying anterior to it. It is helpful to remember that the veins in the plexus over the cystic duct lie parallel with it whereas over the common duct they form a network. If exposure is inadequate at this point, it is sometimes helpful to aid in the rotation of the liver by placing a gauze pack over its dome. Using a ligature carrier or a curved hemostat, two strands of No. 1 chromic catgut are passed around the duct and the latter is doubly ligated close to its juncture with the common hepatic duct. A clamp is then placed on the duct between the bladder and the ligatures to prevent spilling of bile and the duct is divided. The stump may be cauterized with phenol and the ligature nearest the common duct cut short. The other ligature should be left long as a guide until the surgeon is ready to close the wound. The cystic artery can usually be palpated even though not seen at this point and should be brought into view and ligated close to the gall bladder, since it sometimes has a branch running to the right lobe of the liver. The remainder of the operation is usually not difficult unless the gall bladder is deeply buried in the liver. As the serosal reflections are divided the gall bladder comes away from its bed. Hemorrhage is controlled by placing a few interrupted sutures of No. 0 catgut through the cut edges of the peritoneal coat. An infected gall bladder bed should not be closely sutured. Venous ooze from the under surface of the liver can often be checked if a small bit of muscle is cut from the edge of the incision and placed against the liver surface making gentle pressure against it for several minutes. The gall bladder should not be completely severed from the liver until all bleeding is under control since as soon as this is done the liver retracts upward under the costal

margin. We routinely place a soft cigarette drain in the fossa above the duodenum bringing it out on the lateral angle of the wound. We have never had cause to regret this procedure. Not infrequently bile stained drainage material for several days makes the surgeon thankful that the wound was not tightly closed. Advocates of non drainage appear on the horizon now and then only to meet catastrophes sooner or later that make them return to the use of drainage. Moynihan once said that "as I grow older a wee bit of a drain in these cases makes me sleep better." The wound is closed in layers, a continuous row of No. 1 chromic catgut sutures being used for the peritoneum and interrupted sutures of fine alloy steel in the aponeurosis of the muscles. The skin is closed with the same steel alloy. The drain may be removed on the second or third day if the progress is entirely satisfactory. Cholecystectomy performed for gall bladder disease uncomplicated by common duct disease, pancreatitis, etc., has given us 94 per cent cures.

#### COMMON DUCT OBSTRUCTION

Obstruction of the common duct whether from calculus, stricture, neoplasm of the duct itself, or the compression of an extrinsic mass will produce the characteristic manifestation of jaundice. Since the most common cause, common duct stone, is amenable to surgical relief and the other causes may be relieved if not cured, most patients with common duct obstruction should be given the benefit of operative exploration. Hemolytic icterus and intrahepatic biliary obstruction should be excluded by laboratory tests of which the Van den Bergh bromsulphthalein and blood fragility tests are the most significant. Estimation of the degree of jaundice is of importance and, whereas the hue of the skin and the color of the stool serve as a rough guide, a determination of the icteric index is more accurate. When the obstruction is due to a progressive lesion such as stricture or neoplasm, the jaundice also is progressive and relentless. With common duct stone there are usually periods during which some bile flows into the duodenum and the jaundice accordingly lessens intermittently. Patients with common duct

woven silk ones are much better. During the irrigation care must be taken not to wash material upward into the hepatic ducts. This may be prevented by plugging the latter with a small piece of narrow gauze packing. After the lower portion of the duct has been washed clean and the catheter passes freely past the sphincter of Oddi into the duodenum as evidenced by the fact that none of the irrigating fluid returns, the procedure should be reversed and the hepatic ducts irrigated in turn.

Before removal of the catheter passing into the duodenum, the operator standing on the patient's left should palpate with his left thumb and forefinger along the duct as outlined by the catheter. This palpable guide will facilitate the disclosure of a stone oftentimes that has up to this stage been overlooked.

Frequently after one is sure that all stones are removed the catheter cannot be passed into the duodenum. This obstruction may be due to the fact that the catheter tip is unable to find the sphincter opening because of its eccentric position with relation to the dilated portion of the duct above it. When this is the case, if the woven catheter is bent about  $\frac{3}{4}$  of an inch from its tip so as to form an angle of 15 to 20 degrees to the rest of the catheter, and then inserted and rotated on the long axis while gently pushing upon it, the sweeping tip will often find the eccentric sphincter.

The author routinely drains the common duct with a rubber T-tube. Some surgeons use plain or mushroom catheters. The former slip out too easily and the latter may be difficult to remove. If certain precautions are observed with the T-tube, it will prove very satisfactory. It must not be of soft collapsible material nor on the other hand should it be so stiff as to traumatize the duct. The side arms should be about  $\frac{3}{4}$  inch in length and the ends bevelled on their anterior aspects. A notch cut in the cross arm opposite the upright portion allows the side arms to fold and slip out readily when the time comes to remove the T-tube. Interrupted sutures of fine catgut are placed in the wall of the duct above and below the emerging tube to give a snug watertight joint but care must be taken not to narrow the duct in approximating the cut edges. In most cases a cigarette drain should be placed

in the fossa above the duodenum as a precaution before closure of the wound.

Stones impacted in the duodenal portion of the common duct are particularly difficult to dislodge. In some cases it may be necessary to mobilize the duodenum by freeing its superior and lateral attachments and then rotating it forward to expose the posterior wall through which the lowermost portion of the common duct passes. Occasionally a stone in this position can only be removed by a transduodenal approach to the sphincter of Oddi.

*Postoperative care.* After operation these patients have the same need of glucose and blood as before. In addition there are certain problems introduced by the diversion of bile through a choledochostomy tube. The flow must be unimpeded and the tube may have to be gently irrigated with warm saline solution. Too rapid decompression of the biliary system may have untoward effects. The same care must be exercised in this respect as is needed following thoracotomy for empyema or the evacuation of a long standing distention of the urinary bladder. The bile should flow out of the drainage tube intermittently or the tube connected with a decompression apparatus so that the drainage occurs slowly against the pressure of a column of water or gravity. Moreover, the complete diversion of the patient's bile may result in profound biochemical disturbances through the loss of bile salts and other electrolytes. Patients whose bile and pancreatic ferments are being lost in this way sometimes develop marked listlessness, low blood pressure, nausea and debility, sometimes termed "pancreatic asthenia." The deficit can be corrected either by clamping the choledochostomy tube for a long time if this be feasible or perhaps better by returning the bile to the gastro-intestinal tract by pouring it down a duodenal tube which has been introduced into the stomach. As an alternative the bile may be collected, lyophilized (concentrated) and given to the patient in convenient capsules (Mudd). The patient's own bile or that of another patient serves far better as a corrective under these circumstances than does any synthetic chemical substance or ox bile. The length of time a tube is left in the common duct depends upon the circumstances

(3) when the common duct is dilated, thickened or has lost its normal bluish color and appears white or grayish. Unless these rules are followed, stones will be overlooked, and secondary operation may be required.

Eliaeson and Erb recently reported that they had explored the common duct in 18 per cent of a large series of biliary operations with the discovery of stones in the duct in 10 per cent of the total number of cases. When the duct is opened a drainage tube should always be introduced as suture of the duct can not be relied upon.

As a general rule the gall bladder should be removed at the same time that the duct is explored, since it represents a focus of infection even though the disease has extended beyond it. In certain instances however, it is the part of wisdom to do a cholecystostomy and leave the gall bladder in place. Such occasions arise when the nature of the obstructing lesion is such that it may progress after operation or when the surgeon is uncertain whether he has completely and effectively removed the cause of the obstruction.

In the event of a secondary operation the preservation of the gall bladder serves as a useful anatomic landmark in what is apt to be a tedious dissection and also makes it feasible to perform a subsequent short circuiting procedure should it be required. We have made it a rule to save the gall bladder in this way whenever the common duct is large and contains many small stones. The following case illustrates the value of this.

A man 48 years of age was first operated upon in 1931, for recurrent attacks of epigastric pain and jaundice. Stones were found in the gall bladder the common and hepatic ducts and cholecystostomy and choledochostomy were done. During the ensuing 6 years five additional operations have been performed on this patient usually because of recurrences of pain and jaundice. No further stones have been encountered in the gall bladder but in each instance except the last a large number of soft stones have been found in both the hepatic ducts and in the common duct. The last operation was done for persistent biliary fistula. The gall bladder has not been removed in this patient because it has not contained stones since the first operation. The evidence indicates that this patient's calculi have originated in the liver or hepatic ducts. At each operation the author has been thankful for the presence of the gall bladder as a guide leading to the common duct.

*Choledochostomy.* Anesthesia requirements in the jaundiced patient are important and are covered in the discussion of common duct obstruction. The incision may be the subcostal oblique or the right upper rectus which have been described in connection with cholecystostomy. The common duct is exposed in a manner outlined for cholecystectomy. With the oblique incision, improved exposure of the duct is obtained by extending the incision across the midline. If adhesions are present they must be carefully separated employing the gall bladder and the cystic duct as a guide leading toward the common duct. The latter appears as a faintly bluish structure beneath the peritoneum in the right free margin of the gastrophatic omentum. It is overlaid by a plexus of small veins which, if dilated, may give troublesome hemorrhage. When doubt arises concerning which of the structures in the gastrophatic omentum is the common duct, the aspiration of bile with a fine hypodermic needle attached to a syringe will settle the matter. Two sutures of fine (No. 00) catgut are placed in the wall of the duct by means of a small curved intestinal (Ferguson No. 12) needle. The ends of the suture are left long and clamped to serve as tractors. The duct is then incised in the direction of its long axis between the traction sutures. As the bile pours out it is sucked up by an aspirating apparatus with a fine tip or absorbed by a gauze sponge. The opening is enlarged to admit a duct probe or even the finger. The duct is explored toward the duodenum and then upward in an attempt to locate the obstruction. The thumb and forefinger of the surgeon placed behind and in front of the duct will aid in this exploration and may assist in displacing a stone upward. In conducting this exploration the surgeon can sometimes benefit by taking his position on the left side of the patient and inserting his left hand into the wound. Stones may be exceedingly difficult to dislodge but sometimes may be grasped by a curved hemostat or stone forceps. When numerous small stones or gravel are encountered, they may be washed out. A woven silk catheter (No. 10-12 F.) is passed down the duct to irrigate it with warm normal saline solution. An ordinary soft rubber catheter is apt to kink upon itself and

present, a biliary fistula be allowed to form and the tract of the latter then be dissected out of the abdominal wall and implanted into the stomach or duodenum. Every one of these procedures will tax the skill of the ablest surgeon. A leak in the suture line may jeopardize the entire result. Furthermore the dangers of cholemic hemorrhage common to all jaundiced patients exact a large toll and the mortality rate is high even with the best of technical performances.

#### BILIARY FISTULA

The continued discharge of bile through an opening in the abdominal wall after operative tube and drains have been removed, should occasion some perturbation on the part of the surgeon in attendance. It is to be expected that some leakage will occur for a few days following the removal of a cholecystostomy or choledochostomy tube but within a short time all of the bile should be passing through the normal channel into the duodenum. Continued drainage should arouse the suspicion of an obstruction of the duct. This may be due to a stone or to a misplaced ligature. Other and more favorable possibilities are that an accessory cystic duct was not observed during cholecystectomy and is discharging bile through the wound or that the ligature has slipped off the stump of the cystic duct. In both these latter cases the normal bile passage-way into the intestinal tract is patent and under such circumstances the biliary fistula may in most cases be expected to close spontaneously. The importance of the factor of obstruction in the persistence of fistula is well illustrated in the case of drainage of the gall bladder without the extraction of an impacted stone in the cystic duct. Here a more or less continuous communication will persist between the gall bladder and the opening in the skin. It will in this instance discharge mucus rather than bile because the latter is prevented by the impacted stone from reaching the gall bladder, but its behavior is quite different from that following cholecystostomy with a patent duct. The decision to operate or to wait for spontaneous closure in a biliary fistula depends therefore upon the demonstration of the presence or absence of obstruction. Jaun-

dice or clay colored stools give a clue but much more exact information concerning the level and nature of an obstruction is obtained by fluoroscopic observation during and immediately after the injection of a radio-opaque substance, such as iodized oil, into the fistula. This gives a clear delineation of the ductal system and should reveal the true situation. If the injected oil passes readily into the duodenum, operative intervention should be deferred for at least a year. The demonstration of a stone in the common duct calls for choledochostomy. Strictures of the duct require appropriate measures. The final recourse is a dissection of the fistulous tract with implantation of it into the stomach or duodenum. This operation is neither as easy nor as successful in practice as it sounds in theory.

#### CANCER OF THE GALL BLADDER AND EXTRAHEPATIC BILIARY DUCTS

Carcinoma has been estimated to be found in between 1 per cent and 2 per cent of all cases of disease of the gall bladder and its ducts. This incidence, therefore, is less than the mortality of the best elective cholecystectomy and the removal of silent gall stones can not therefore be urged on the ground of their threat of the development of cancer. The diagnosis of cancer confined to the gall bladder is rarely made before operation and later frequently only by histopathological examination. The obvious surgical procedure is a cholecystectomy unless the growth has extended beyond the confines of the gall bladder.

Cancer of the ducts manifests itself by relentless and painless jaundice. Potter has called attention to the fact that it occurs about as frequently as cancer of the head of the pancreas and about 3 of 5 cases are erroneously so diagnosed.

It is well known that surgical attack on carcinoma of the ducts presents much the same problem as stricture with the additional urgency to perform radical extirpation when feasible. A few cases of successful resection of the common duct with implantation of the stump into the duodenum are on record. More often the only possible course open to the surgeon will be a palliative cholecystogastrostomy or cholecystoduodenostomy.

of the case, e.g., the amount of bile passing through the sphincter of Oddi by the normal route and the degree of hepatitis present. Ordinarily 2 weeks is a sufficient period for drainage but occasionally prolonged drainage of several months is desirable. It is of the greatest importance in these patients to observe both clinically and by laboratory tests the progress of the jaundice. The color of every stool passed or the return from each enema should be carefully noted on the patient's record for this gives a reliable index of the flow of bile through the normal channel into the intestinal tract.

#### STRICTURES OF THE BILIARY DUCT

Although other etiological factors are possible, the majority of strictures are the result of operative trauma. Their correction presents one of the most difficult problems in abdominal surgery and the operative mortality rate is high, therefore, the utmost caution should be exercised to avoid damage to the ducts in doing biliary surgery. Two or three dangerous practices in the performance of cholecystectomy deserve particular attention. When troublesome hemorrhage occurs from the cystic artery a clamp or a ligature carelessly placed may include the right hepatic duct together with the cystic artery. The same error may be made by placing a clamp blindly on the neck of the gall bladder preparatory to dividing the cystic duct. To insure against this the cystic artery should always be distinctly visualized or palpated and ligated close to the gall bladder either before or immediately after ligation of the cystic duct. If the cystic artery be accidentally torn, a clamp should never be placed blindly in a field obscured by blood. A second common error arises in making strong traction upward on the gall bladder so that the junction of the cystic with the common hepatic and common ducts is peaked. Under these circumstances the ligature intended for the cystic duct may encircle the common hepatic or the common ducts either in entirety or in part. The result will be a biliary fistula if the misplaced ligature blows off or, depending upon how much has been included in the ligature, a partial or complete stricture of the common duct. The

possibility of these calamitous sequelae is ample justification for the absolute dictum that cholecystectomy should never be attempted in cases in which the relations of the three ducts can not be visualized.

The surgeon who opens an abdominal cavity for the repair of damage to the biliary ducts invariably faces a trying and tedious session. The omentum and duodenum will usually be found adherent to the under surface of the liver at the former site of the gall bladder. The identification of the common duct itself may be an exasperating and time consuming problem. Having identified the ducts and demonstrated the level and nature of the stricture, several possibilities present themselves for overcoming the obstruction.

An adequate length of duct proximal to the stricture is a prerequisite to any form of anastomosis. The latter must be accomplished without tension on the suture line and to ensure this it is easier to mobilize the duodenum and draw it upward than to make any downward traction upon the duct itself. An ideal procedure would be a resection of the narrowed portion of the duct and an end to end anastomosis. This is feasible only with very short strictures as otherwise tension will ensue. The sutures must be meticulously placed and should be of the finest material and the needle should be small. Care must be taken to avoid inversion of the edges of the duct wall, thus giving rise to a new stenosis. A rubber tube should be used to maintain patency of the duct during the stage of edema following operation. If anastomosis can not be done, the proximal portion may sometimes be implanted into the mobilized duodenum—hepaticoduodenostomy or choledochoduodenostomy. Plastic procedures to overcome narrowing are rarely applicable. One of the Heineke-Mikulicz type which is satisfactory in correcting pyloric stenosis will produce linking if attempted on a bile duct. Occasionally a stricture may be split in the axis of the duct and sutured around a tube. The senior author has successfully followed the suggestion of Dr. Julian Johnson that parallel relaxation incisions be made in the duct and a tube be placed in the lumen. Lahey has suggested that as a last resort if insufficient proximal duct tissue is

# OBSTETRICAL INFLUENCES ON THE WEIGHT CURVE OF THE NEWBORN

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THE conception that the "normal" newborn infant may be in a state of mild shock is relatively new. If such a conception proves to be correct, it should greatly modify not only our routine care of newborn babies but many obstetrical procedures.

Practically all laymen and most physicians think of labor from the mother's point of view. The baby usually receives scant attention until the process is over. Many procedures have been advanced in recent years to make labor easier for the mother but very few have been suggested to make delivery safer for the child. After all, the function of labor is to produce healthy children. True progress in obstetrics should certainly be as much concerned with insuring the baby's safe passage through the birth canal, as with making labor more endurable for the mother.

A most casual inspection of newborn statistics should be sufficient to convince anyone that this is not an insignificant problem. In hospital practice, about 4 per cent of the newborn babies are either stillborn or die in the first week of life. More than half of these are due to accidents of labor, especially cerebral injury and asphyxia. It is estimated that about seventy thousand recognized cases of cerebral hemorrhage in the newborn occur in the United States each year. A very large proportion of the inmates of public institutions for the mentally or physically handicapped are cases resulting from birth injury. Therefore it seems appropriate that we gather data which may throw additional light upon the factors responsible for these injuries.

Labor in the human is quite a different problem from that in even the largest of the mammals because of the large size of the infant's head and the disproportion between it and the mother's pelvis. It has been suggested that the amount of trauma to the head, which is necessary under even the most ideal

conditions, is sufficient to produce a considerable degree of shock in the infant. Changes in blood pressure, blood volume, and blood flow in newborn babies, similar to those found in patients with surgical shock have been reported. Clinical evidence of this shock is the apathy, refusal of food, and marked loss of body weight almost invariably observed during the first days of life.

The loss of weight has always been called "the physiological weight loss of the newborn." It has been explained by the loss of meconium and urine from the body, by the vomiting of mucus, and by the fact that the baby usually receives little or no food or fluid during the first days of life.

If we examine the growth curve of the ovum from the time of fertilization until birth, we will observe that it is rapid and continuous. Also, if we examine the growth curve of the infant after it has recovered from the effect of birth, it is again rapid and continuous. It does not seem reasonable that such a marked interruption of development, sometimes involving a loss of 10 per cent of the body weight can be a "physiologic" phenomenon. Furthermore, if the various factors usually listed as accounting for this loss of weight are all added together they are sufficient to explain only a part of the weight lost by most babies. Apparently some changes must occur which have not previously been considered.

One of the outstanding features of "shock" is a disturbance in the water metabolism involving the loss of large amounts of water from the body, chiefly through the skin and lungs. The work of Collier<sup>1</sup> on the water metabolism of patients after operation has demonstrated this thoroughly. While similar studies have not been made on newborn infants, the analogy between them and adults after operation seems sufficiently close to

<sup>1</sup>COLLIER, F. A., and MADDOCK, W. G. J. Am. M. Ass., 1932, 99, 875-880.



## CONCLUSIONS

Early surgery in the acute attack as well as in the course of the disease will reduce mortality and morbidity. Judicious choice of the procedure to be employed is necessary. The surgeon should recognize his own as well as his patient's limitations. It might be better to leave a difficult case of impacted stone behind the duodenum until drainage through a cholecystostomy relieves the dangerous jaundice.

Postoperative care is extremely important. It should be directed toward the prevention of hypoventilation and pulmonary complications by posture, deep breathing exercises, change of position, suction drainage of the stomach as a defense against abdominal distention, the prevention of concealed hemorrhage and biliary peritonitis by the use of a drain, the maintenance of liver function by the use of decompression drainage and the administration of blood or glucose and salt intravenously to sustain metabolic and fluid

balance. Only by strict attention to these principles can we hope to reduce the mortality and morbidity of biliary disease.

## REFERENCES

- 1 BEAVER M G Arch Surg 1929 19 321
- 2 COLLIER FREDERICK and FORSBERG, F C Ann Surg 1937 105 791
- 3 ELIASON I L and LEE Ann Surg 1935 101 460
- 4 ELIASON I L and FERGUSON L F Surg, Clin N America 1928 8 840
- 5 FLINT E R Lancet 1933 224 187
- 6 GRAHAM H T Am J Surg 1936, Nov
- 7 HEUER GEORGE J Ann Surg 1937 105 739
- 8 JUDG J S and PHILLIPS J R Ann Surg 1933 98 771
- 9 LARBY FRANK Ann Surg, 1937 103 763
- 10 MASON J T J Am M Ass 1932 90 891
- 11 MILLER PIERCE H Ann Surg 1930 92 644
- 12 MUDD STUART and FLOSDORF E W J Immunol 1935 29 389
- 13 POTTER L B Ann Surg 1933 98 169
- 14 SMITH MORRIS J Ann Surg 1933 98 766
- 15 STONE HARVEY and OWINGS J C Ann Surg 1933 98 700
- 16 TAYLOR FREDERICK Surg Gynec & Obst 1936 63 296
- 17 ZENINGER M M Ann Surg 1932 96 406



curve of any given group by means of a tabulating machine. This permitted analysis of data which would be impossible by means of ordinary hand methods and in addition assured absolute accuracy.

The weight curve for the whole group is shown in Chart 1. This and all subsequent curves are expressed in percentage of the birth weight, rather than in ounces, so as to make comparison of groups of different weights on a common basis. The birth weight is taken as 100 per cent. Figures in parenthesis indicate the number of babies. The other figure is the average initial weight. The loss in weight the second day was 3.47 per cent. The maximum loss occurred on the third day and was exactly 5 per cent of the original weight. This represents a loss of almost exactly 6 ounces for the average baby. Only a very slight increase occurred on the fourth day but from then on the gain in weight was rapid and continuous. On the eighth day, the average baby was 1.33 per cent below birth weight. The maximum loss of 5 per cent of the birth weight is considerably less than the figure usually given for similar groups. VonReuss gives from 6 to 10 per cent as the usual loss. This is probably due to the fact that practically all of the babies in the nurseries at the Woman's Hospital are offered fluids of one sort or another during the first days of life. This, however, is a question which we will discuss at another time.

Chart 2 shows the comparative weight curves of the babies of primiparæ and multiparæ. VonReuss states that the children of primiparæ lose more weight and recover more slowly than those of multiparæ due to the later appearance of the mother's milk. In our series, the curves are practically identical except that at the eighth day, the babies of the primiparæ have not regained as much of their weight. If the trauma of labor is a factor in increasing the weight loss of the newborn, it might be expected that it would be greater in the case of primiparæ, but this is obviously not the case. However, as will be subsequently shown, the duration of labor which is usually much longer in the primiparæ, may tend to offset such an effect.

Chart 3 shows the effect of the various types

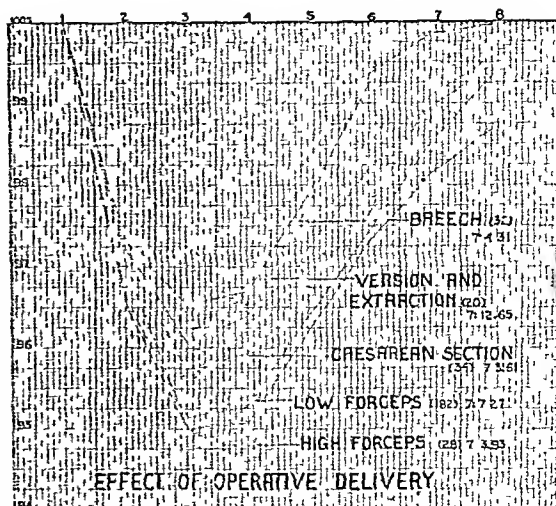


Chart 3 Effect of operative delivery

of operative delivery on the weight curves of the newborn. It will be noted that all but one group (high forceps) lost less than the average. While the curve is not shown on this chart, obviously babies born by normal delivery lost correspondingly more than the average. There were 32 babies born by breech delivery in which the maximum loss in weight was but 3.47 per cent. This group was over birth weight on the seventh day. There were 20 babies delivered by version and extraction in which the maximum weight loss was 3.92 per cent. They were practically at birth weight on the eighth day. There were 34 babies born by cesarean section in whom the maximum loss was 4.25 per cent. They were 0.50 per cent below weight on the eighth day.

It should be noted that in all three of these groups, trauma to the head is either absent or greatly reduced because it is not the presenting part and does not receive direct pressure as in the case of cephalic presentation. There were 182 cases in which low forceps were applied. The loss in this group is only slightly less than the average but very definitely so when the size of the group is taken into account. Their better recovery by the end of the period is also significant.

There were 28 cases in which high forceps were applied. The weight curve of this group closely corresponds to the average except for

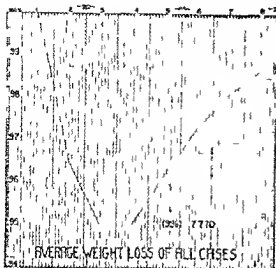


Chart 1: Average weight loss of all cases

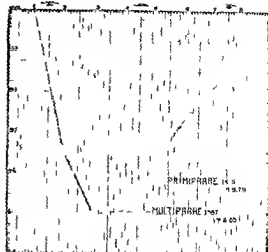


Chart 2

assume that similar processes are taking place. If this be true, the weight lost by the newborn is largely due to water lost from the body and should be more or less an index to the degree of shock.

In the observation of a large number of newborns, we have been impressed by the fact that babies of similar size, apparently born under similar conditions, and fed and cared for in like manner vary widely in the amounts of weight which they lose. Some factors obviously must be operative in one case which are not present in the other. If birth shock is a factor in some of these cases conditions during and after labor which might tend to increase the birth trauma should be possible of detection by an inspection of the delivery record.

With this in mind, we have collected a considerable series of cases on which accurate observations of many of the possible factors which might involve the baby including the food and fluid intake, were carefully recorded and tabulated in such a manner as to make comparison of their various weight curves possible.

In this paper we wish to present an analysis of the influence of various obstetrical and neonatal procedures on the weight curves of different groups of infants. The consideration of the food and fluid intake and a correlation

of the two series will be the subject of a later report.

Between November, 1933, and June, 1936, records were made of all the babies born in the Woman's Hospital at Detroit. These included all social groups and were delivered by physicians with a considerable variation of obstetrical training. Accordingly, a very good general cross section was obtained. During this period, about 1,250 babies were born. Only normal children were included in this study. Any baby who was ill or had a recognized abnormality or whose record was not complete was excluded from the series. The babies in this series left the hospital at the usual time in apparently good condition. This left a group of 996 babies which form the basis of this analysis.

The data were tabulated according to the punch card method. All data concerning each child were punched into an individual card according to a previously established code. This included data about the pregnancy, delivery, neonatal period, the weight for each of the first 8 days and a complete record of the food and fluid intake for each day. After the cards were complete it was a simple matter to sort them into any desired group or subgroup by means of a mechanical sorting machine, and to obtain the cumulative weight

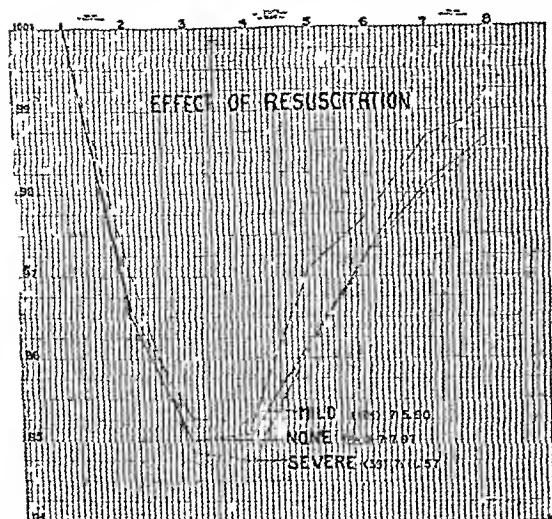


Chart 6 Effect of resuscitation

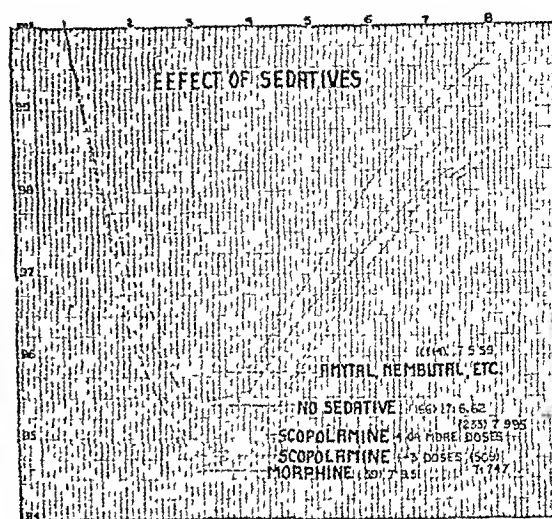


Chart 7 Effect of sedatives

canal tends to minimize the trauma to the head

Chart 5 shows the effect of pituitrin on the weight curve of the infant. There were 24 cases in which pituitrin was used in the first stage of labor and 102 in which it was used during the second stage. The initial weight loss of both groups does not seem to show any significant deviation from the average curve although both groups lost slightly more. In both cases, however, the recovery is slower than average and when pituitrin was used in the first stage, the babies were 2.44 per cent below weight on the eighth day. This is nearly twice as much below weight as the average baby. Whether this bears any relation to the use of pituitrin or is merely an accidental finding is open to question. It would naturally be expected that the pituitrin would increase the trauma to the baby's head, but if so it is not indicated in the amount of the initial loss.

Chart 6 shows the effect of resuscitation in the newborn on the subsequent weight curve. The cases were divided into two groups, those in which the asphyxia was mild, and those in which it was severe. Severe cases were those with prolonged cyanosis, in which the tracheal catheter was used or in which artificial respiration was needed.

The curve of those babies in whom resuscitation was not used, corresponds almost ex-

actly to the average. When mild measures were necessary the loss was slightly less; when severe measures were used it was slightly more. If there is any significance to these findings, it is not clear to the writer.

Chart 7 shows the effect of sedatives given to the mother on the infant's weight curve. These are divided on the following basis, no sedative, scopolamine 1 to 3 doses, scopolamine 4 or more doses, morphine (usually in combination with scopolamine), and amytal, nembutal, etc.

In cases in which patients received no sedative the babies lost considerably less than average (4.59 per cent). Those receiving amytal, etc. lost a maximum of 4.23 per cent, which is strikingly less than average. Recovery in this group was also better than in any other. The amount of scopolamine given did not seem to alter the curves of those two groups nor did the addition of morphine cause any appreciable change. All of these latter groups lost slightly more than average and were somewhat slower in recovery. There are two possible explanations for these findings. Amytal, etc., act quite definitely to slow labor, whereas scopolamine does not. Babies whose mothers receive amytal are usually very listless and apathetic for the first 24 hours. Scopolamine seems to render the baby hypertonic and irritable. The energy conserved in

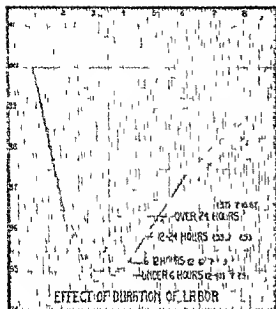


Chart 4. Effect of duration of labor

the continued loss of weight into the fourth day. This could perhaps be interpreted as the result of increased trauma but is more probably due to special feeding problems. Mothers in whom high forceps application is necessary would probably be in poor condition longer than the average mother with a consequent reduction in milk production.

It has been suggested that in the case of breech and version deliveries, meconium is often expelled during labor so as to make the original weight less and the percentage loss correspondingly less. However it appears that meconium is only occasionally expelled and then rarely as much as an ounce. If we should recalculate these cases on the basis of one ounce more on their original weight (which does not seem likely) their weight curve then would be very close to the cases delivered by caesarean section.

In any event it seems very striking that in the groups in which trauma to the head is minimized the weight loss of the babies was markedly reduced. There is also room for argument that the use of low forceps, toward the second stage of labor, somewhat reduces the trauma to the baby's head.

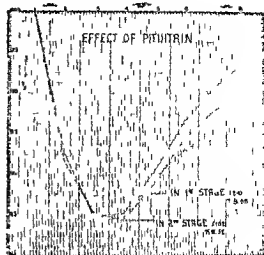


Chart 5. Effect of pituitrin

Fully as significant as the original loss in evaluating the amount of injury to the baby is the very considerably faster recovery made by all of these groups. These results should not be interpreted as favoring breech and version delivery. These records are only on normal babies. It is well known that the incidence of tentorial tears is much higher in this type of delivery.

Chart 4 shows the effect of the duration of labor upon the weight curve of the baby. The cases were divided into four groups. Those in which the labor was less than 6 hours in which it was from 6 to 12 hours from 12 to 24 hours and over 24 hours. There seems to be little if any difference in the curves of the babies in the first two groups. Both of them lost slightly more than the average and are significantly slower in their recovery by the eighth day. The 12 to 24 hour group conforms almost exactly with the average but the loss is slightly less throughout. However in the group in which labor lasted over 24 hours the difference is extremely striking. The maximum loss was but 3.06 per cent, and they were 1.07 per cent above birth weight on the eighth day. Long slow labors are often the result of weak pains. This marked reduction in the weight loss of this group coupled with their very good recovery strongly suggests that slow gradual progress of the child through the birth

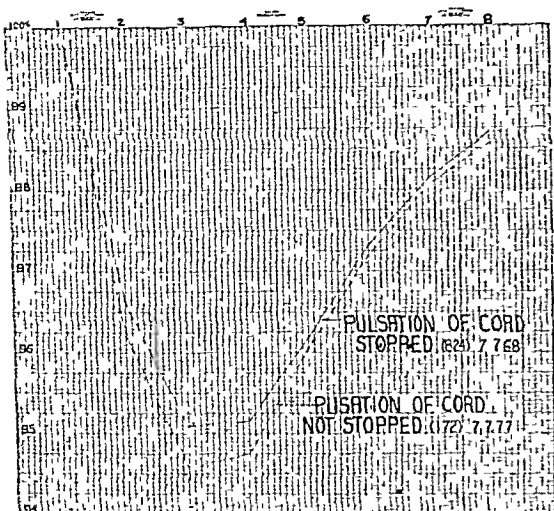


Chart 10

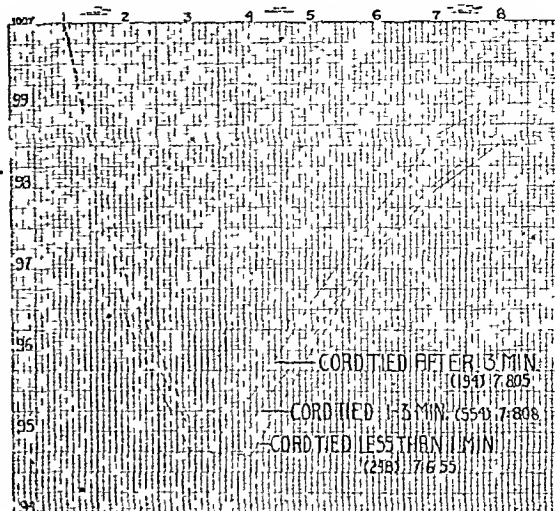


Chart 11

each infant. It would seem that the reason for the variation in the drop in temperature lays not in external influences but to conditions within the babies themselves. It may be that the drop in temperature is in itself responsible for the increased loss in weight but it seems much more likely that the drop in temperature is merely another method of measuring the degree of birth shock. Lowered body temperature is one of the characteristics of shock and it would be natural to find the loss of weight corresponding to the drop in temperature if we assume that both of these factors are indices of shock.

Charts 10 and 11 show the effect of the time of tying the umbilical cord on the babies weight curve. In Chart 10, the cases are divided into two groups according to whether the cord was tied before or after pulsation had stopped. It will be seen that when the cord was tied before pulsation stopped the loss in weight was distinctly greater and that the curve remained below the other group throughout. In Chart 11, the cases were divided into three groups: (1) the cord was tied in less than 1 minute after birth; (2) it was tied between 1 and 3 minutes after birth; and (3) it was not tied until more than 3 minutes after birth. It will be readily seen that the longer the time that elapsed, the less the weight the babies lost. It has been estimated that the baby re-

ceives from 1 to 2 ounces more blood (a very considerable amount to a newborn) when the cord is not tied until after pulsation stops than when it is tied at once. Inasmuch as blood volume is one of the important factors in the

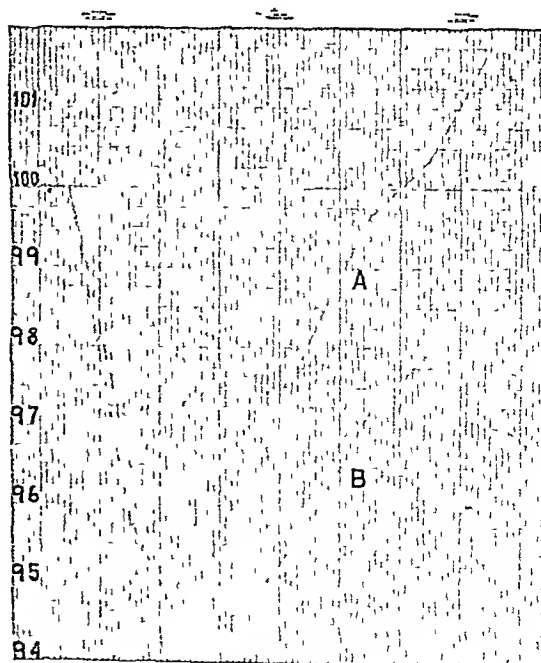


Chart 12

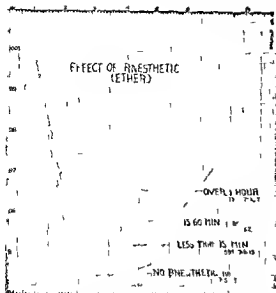


Chart 8 Effect of anesthetic ether

the first group might possibly reduce the weight loss, or the depression of respiration might cause less water to be lost through the lungs. The effect, however, seems very definite. The interpretation will bear further study.

Chart 8 shows the effect of ether administered to the mother on the weight curve of the baby. The cases were divided into those receiving no anesthesia, those receiving ether for less than 15 minutes, those receiving ether from 15 to 60 minutes, and those receiving ether for over 1 hour. It is very evident that the amount of ether administered to the mother bears a direct relationship to the initial weight loss of the infant and to the rate of recovery of the weight. The more ether the mother received, the less the baby lost and the more rapid the recovery. When no anesthetic was given the maximum loss was 53 per cent and the babies were still 23.7 per cent below weight on the eighth day. When ether was given for over 1 hour, the maximum loss was 4 per cent and weight at the eighth day was +58 per cent. There are several possible interpretations of this very interesting observation. It might be that the administration of ether slows down the progress of labor and may have a direct effect on the child's nervous

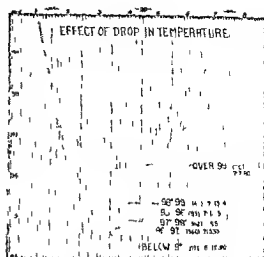


Chart 9 Effect of drop in temperature

system, or as seems quite likely, it might modify the baby's respiration with consequently reduced water loss from the lungs.

Whatever the explanation, the effect seems so definite as to leave little doubt that ether given to the mother tends to reduce birth shock in the baby.

Chart 9 shows the effect of the drop in the baby's temperature during the first hours after birth. The cases are divided into groups according to the lowest point the temperature reached in the first 24 hours after birth, one group for each degree. It will be observed that with a single exception (those between 95 and 96 degrees) the drop in weight is directly proportional to the drop in temperature. It is possible that in the exceptional group special administration of parenteral fluid may have been used in certain cases which modified the curve of this group. The maximum loss in those in which the temperature fell below 93 degrees was 57.7 per cent while in those where it did not fall below 99 degrees, it was but 3.80 per cent. The regular progression upward of the weight curve with each degree of rise in temperature is very striking and must be significant. The rate of recovery is also proportional to the original loss. The temperature of the delivery room was never below 85 degrees and usually near 90 degrees. Heated cribs are provided for the reception of

# EVALUATION OF THE INTRADERMAL TEST FOR PREGNANCY

SUSANNE R. PARSONS, M.D., F.A.C.S., Santa Barbara, California

THE report of Gilfillen and Gregg on a "new, rapid, and economical" test for pregnancy which appeared in September, 1936, has led some of us to attempt to repeat their work. It seems worth while at this time to collect the data presented in the reports of these other workers and to add thereto a small series of tests which I have carried out

An ideal test for pregnancy must meet certain requirements. It must first and foremost be at least 95 per cent accurate. It should be rapid, economical, and so simple that it may be available to workers lacking elaborate laboratory facilities. The Aschheim-Zondek test meets the first but requires several days and a large and always available supply of animals. Its various modifications offer little improvement in these respects.

Gilfillen and Gregg report that the skin test for pregnancy meets all the above requirements and in their hands they found it "proved more delicate than the Aschheim-Zondek test in border cases." The test is based on the idea that an anterior pituitary-like substance is present in the circulation of pregnant women, therefore these women would not be sensitive to this substance injected intradermally. Non-pregnant women would show a reaction, as it would not be present in the blood stream. Their technique consists of the intradermal injection of 2 minims of antuitrin-S in the flexor surface of the forearm, after it has been cleansed with sterile water. The reaction occurs usually within a few minutes, or may be delayed as long as 2 to 3 hours in elderly women. An area of erythema, 7 to 40 millimeters in diameter about the site of injection, develops in non-pregnant patients. In pregnancy no reaction occurs. They used the test not only for pregnancy, but in gynecological conditions, as abortion, ectopic pregnancy, hydatidiform mole, and teratoma of the ovary. A series of

24 controls, known non-pregnant patients, confirmed the accuracy of their test, which they state to be reliable in all these conditions.

Although Gilfillen and Gregg make no mention of the fact, this test was neither new nor original with them. It was first used by Porges and Pollatschek and reported before the Society for Internal Medicine in Vienna, March, 1929. Prolan was used and the readings were made the following day. This report was enthusiastic and it was claimed to be reliable in all cases but one, a woman with a hypophyseal tumor. No statement was made as to the number of cases tested, however.

Alfred Deutsch repeated this work on a series of 45 pregnant and 65 non-pregnant women. He concludes that there is no essential difference in skin reaction between the pregnant and non-pregnant. Only 11 of a series of 65 non-pregnant women gave a strong reaction. Strauss (10) also ran a series of intradermal tests using non-pregnant and pregnant females, males, females at menopause, postpartum women, cases of ectopic pregnancy and of abortion, as well as menstruating women. He concludes the test "is neither definite nor reliable." He states that in a private communication Porges and Pollatschek verified his conclusions, after they had used the test more extensively in Vienna.

I decided to attempt to repeat the work of Gilfillen and Gregg, using the technique as described by them. Further, it seemed wise to check the results with other anterior pituitary-like substances, and for this follutein and antophysin were chosen. A fourth injection for control, of sterile water with a few drops of glycerine, was made. Our technique consisted in thorough cleansing of both forearms, flexor surfaces, with sterile water. Two minims of each solution, antophysin, antuitrin-S, follutein, and glycerine-water, were injected intradermally, and the reaction ob-



determination of shock, it is easily conceivable that the loss of blood by the early tying of the cord might tend to increase an existing tendency to shock.

Chart 12 shows the result of selecting cases in which several of the favorable factors are present and another group in which the corresponding unfavorable factors are present. Group A represents a group of 32 cases born by non-cephalic presentation in which the duration of labor was over 12 hours in which the temperature never fell below 96 degrees, in which ether was administered for 15 minutes or more and in which the cord was not tied until pulsation had stopped. Group B represents a group of 35 cases born by cephalic presentation, in which the duration of labor was less than 12 hours, in which the temperature dropped below 97 degrees, in which ether was given for less than 15 minutes, and in which the cord was tied before pulsation had stopped. The weight curves speak for themselves. Group A lost weight only during the first 24 hours, the maximum loss being 3.53 per cent. From this point they recovered rapidly. On the fifth day (end of fourth day) they had practically recovered

their birth weight and on the eighth day, they were 1.76 per cent over birth weight. Group B lost much more during the first day, and continued to lose sharply during the second day, the maximum being 5.81 per cent. On the fifth day they were still 4.47 per cent below birth weight, considerably more than Group A on the second day. On the eighth day, they were still 2.55 per cent below birth weight.

#### SUMMARY

1. A statistical analysis of 996 newborn babies is presented with the view of determining whether obstetrical and neonatal procedures influence weight loss in the newborn.

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days postpartum, and duration of pregnancy have little influence on readings. Follutein was found to react more often both in the pregnant and non-pregnant groups, due perhaps to a protein reaction, rather than to the anterior pituitary-like hormone present.

Difficulty was experienced in making the readings, as pigmentation of the skin, and degrees of erythema were influencing factors, which often left me in doubt of the classification into which the test should fail. We have found this intradermal test thoroughly unreliable, and feel that it gives far too high a percentage of error for it to be trusted clinically. This is corroborated by the work of Strauss and Deutsch.

Gruskin reports the use of a placental extract which has been heated, with the result that the anterior pituitary-like gonadotropic fraction is destroyed. He claims good results.

In July, 1936, Schneider and Cohen report a series of 118 tests carried out on 95 females and 23 males. There were 21 pregnancies, 17 postpartum, or postabortal, 6 normal, and 74 with a wide variety of diagnoses. The results of the test showed 11 were not pregnant, 107 pregnant. Actually there were 21 pregnancies.

Isadore Gersh reports a series of 113 tests of which 50 were normal men and non-pregnant women; 48 were known cases of pregnancy of 2 or more months' duration and 15 were 1 to 9 days postpartum. In this series 3 injections were made, a control of normal saline with 0.5 phenol, antuitrin-S, and an anterior pituitary-like hormone extracted from placental tissue at the University of Colorado, Department of Pharmacology. The results of the tests show both false positive and false negative reactions. With antuitrin-S 20.8 per cent false negative results were obtained in the pregnant series and 6.6 per cent in the postpartum cases while 81.6 per cent of the men and 66.6 per cent of the non-pregnant women showed false positives. The control injection gave erythematous reactions in 8.8 per cent in 30 minutes and 5.4 per cent in 60 minutes.

Frank and Wahrsinger report a series of 198 cases. They used three different hormonal products, antuitrin-S<sup>1</sup>, anterior pituitary

luteum<sup>2</sup> and progestin<sup>3</sup>. With antuitrin-S 163 cases were tested and showed that of 112 definitely pregnant women 28 gave positive skin reactions (non-pregnant reaction). Eight gave doubtful and 76 no reaction. This gave a 68 per cent accuracy. There were 21 postpartum women, all of whom gave strongly positive reactions. The second hormone was used in only 6 pregnant patients, 2 gave positive, 3 negative, 1 doubtful skin reactions. The third hormone was used in 29 cases and 10 known pregnant patients gave 9 positive skin reactions and 1 doubtful. The result of the entire series of 198 cases shows that 98 per cent of cases including pregnant women gave a positive skin reaction (non-pregnant).

Table I shows the results of the several series of cases presented by workers other than Gilfillen and Gregg.

TABLE I

	Total cases	Known pregnant	Non-pregnant	Positive skin reaction (non-pregnant)
Deutsch	110		65	11
Schneider	118	21		11
Gersh	113	48		20.8%
Frank and Wahrsinger	198	112		28
Parsons	140	100		34
Total	679			

These results show little variation with the use of different preparations of the hormone. Among those which have been used were antuitrin-S, an anterior pituitary-like hormone extracted from placental tissue<sup>4</sup>, anterior pituitary luteum, progestin, antiohophysin<sup>5</sup>, follutein<sup>6</sup>.

In conclusion, therefore, we may say the intradermal skin test, in 67.9 cases has proved entirely unreliable in the hands of all workers who have attempted to repeat the work of Gilfillen and Gregg. There seems to be no choice among the various hormonal preparations used; all yield equally unreliable results.

This work was done under a grant from the St. Francis Hospital Research Fund. The writer is indebted to the Santa Barbara General Hospital for generous use of material and also to the Nurses of St. Francis and Santa Barbara Cottage Hospitals for co-operation in making these tests.

<sup>1</sup>Ayerst<sup>2</sup>Upjohn<sup>3</sup>University of Colorado<sup>4</sup>Winthrop<sup>5</sup>Squibb<sup>6</sup>Parke, Davis and Co

served at 15, 30, and, if no reaction had occurred by this time, again at 60 minutes. The solutions were made up freshly and kept on ice when not in use. A series of 140 women—100 known pregnant, 10 postpartum, and 30 known non pregnant patients—were tested. Careful note was made of the ages of the patients, the duration of pregnancy, and the time of the interval before reaction occurred. In the control group the relation to menstruation was noted, and in the postpartum group, the days since delivery. Our results were as follows:

In 100 cases of known pregnancy, no reaction with any of the solutions was shown in 66, in which group 1 ectopic is included, of the 34 cases which showed reaction 30 reacted with follutein only, 4 with all three solutions. Thus we see that follutein failed in 34 per cent, antuitrin S and antophysin in 4 per cent.

The possible influence of age was studied as follows. Of the total 100 patients, 29 were under 20 years of age, 56 were 21 to 30, 15 were 31 to 40. Of the 66 which showed no reaction, 18 were under 20, 38 were 21 to 30, and 10 were 31 to 40. Of the 30 reacting with follutein 9 were under 20, 17 were 21 to 30, and 4 were 31 to 40. Of the 4 reacting to all three solutions 2 were under 20, 1 was 21 to 30, and 1 was 31 to 40. These figures fail to show any evidence of age influence.

Studying the reaction from the standpoint of duration of pregnancy, we have 8 cases of pregnancy of 1 month's duration, 3 of 2 months, 8 of 3 months, 7 of 4 months, 7 of 5 months, 11 of 6 months, 18 of 7 months, 24 of 8 months, 12 of 9 months, 2 of 10 months.

In the 11 cases of 2 months or less duration, 8 reacted to one or more solutions, so that only 3 correct reactions were given. There were 4 who reacted to follutein alone and 4 who reacted to follutein, antuitrin S, and antophysin, but not to the control. In the cases of 3 months' duration, 5 showed no reaction with any solution, and 3 reacted only to follutein. Thus we see in the first 2 months the test proved incorrect in 72 per cent with all solutions. Almost one third error was shown in follutein alone and in folli-

tein, antuitrin S, and antophysin. As the duration of pregnancy increases, the percentage of error is reduced. The 3 month group showed that over 50 per cent gave positive pregnancy test.

The postpartum group gave the following results:

Number of cases	Days postpartum	Reaction
1	1	No reaction to 3 solutions
1	2	No reaction to 3 solutions
3	4	1 no reaction, 1 to follutein, 1 to antophysin
2	6	All reacted with follutein
1	9	No reaction to 3 solutions
2	10	All reacted to follutein only

Thirty controls of known non pregnant women were used, the ages varied from 19 to 50. In 6 of these there was no reaction observed with any of the solutions, or 20 per cent positive pregnancy test in known non pregnant individuals. In 15 there was a very faint reaction with follutein only. In 1 there was a definite reaction with follutein only. In 1 case both follutein and antuitrin S gave a faint reaction. Seven cases gave a definite reaction with all three solutions, and no reaction with the control injection. The ages of the 6 patients with no reaction were 19, 20, 21, 25, 37, 50. The ages in 7 with definite reaction were 21, 38, 30, 38, 35, 36, 26. The ages of the first group average 28 years, that of the second, 30 years, which slight difference could be of little significance in the result of the test.

The relation to menstruation, in the group of 6 with no reaction was 25, 30, 19, 10, 20 days past onset of last period. This shows little essential difference in the two groups.

In all groups studied, the reaction occurred promptly within 15 minutes, and in no case was it observed to show up as late as 30 minutes after the injection was made.

#### DISCUSSION

The intradermal test as shown by the foregoing figures gives a very unreliable test for pregnancy, since it is inaccurate in both the control group and in the known pregnant group with an error of from 4 to 72 per cent. In the early months of pregnancy when we particularly desire an accurate test, we find as high as 72 per cent error. Age, menstruation,

# THE RÔLE OF TUBERCULOSIS IN ANAL FISTULA

LOUIS A. BUIE, M.D., NEWTON D. SMITH, M.D., and RAYMOND J. JACKMAN, M.D.,  
Rochester, Minnesota

**T**HIS study was undertaken in order to clarify, if possible, the controversy regarding tuberculosis as a cause of fistula-in-ano. Opinions have varied widely. Some believe that the majority of fistulas are of tuberculous origin; many feel that any relationship that may exist between anal fistula and tuberculosis is not significant. One probable reason why fistulas are considered to be of tuberculous origin is that healing often fails to occur following operation. Although a relationship between fistula-in-ano and phthisis was observed more than 2000 years ago, opinions then, as now, varied greatly. In early Roman literature (1) it was recorded that many patients who had anal fistula recovered promptly after operation but others did so slowly or not at all, and that many such patients died of "consumption." It was therefore believed that all fistulas drained infectious "humors" from the "system" and if closure were attempted disaster would result. Heurteloup actually advised the production of artificial fistulas in cases of consumption.

When we assumed our task, it appeared that there were five phases of the problem which required solution, namely: (1) What is a tuberculous anal fistula? (2) What percentage of anal fistulas are tuberculous? (3) In what percentage of cases of anal fistula is the tuberculous process a primary one? (4) What percentage of anal fistulas occurring among tuberculous patients are tuberculous? (5) If a tuberculous anal fistula is known to be present, should the treatment be altered?

Satisfactory answers are not available in the literature. The chief reason for the wide variation in opinions is that there is disagreement concerning what criteria are proper for the identification of a tuberculous anal fistula.

From the Section on Proctology, The Mayo Clinic, and The Division of Proctology, The Mayo Foundation. Abridgment of thesis submitted by Dr. Jackman to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Proctology.

## REVIEW OF LITERATURE

A voluminous literature bears testimony to the difference of opinion on this subject. There are several reasons why the incidence of tuberculous anal fistula reported in the literature reviewed by us varies from 1.4 per cent to 61 per cent. Some studies were made in general hospitals; others were made in tuberculosis sanatoriums or in hospitals which had a special service for tuberculous patients. Often, histological or bacteriological study has not been made and systematic methods have not been used for diagnosis.

As to the frequency of pulmonary tuberculosis and co-existing anal fistula, figures quoted from various tuberculosis sanatoriums vary from 7 to 18 per cent. A wide variation is noted in the incidence of tuberculous fistula among patients who have pulmonary tuberculosis. Figures reported vary from 4 to 100 per cent.

What constitutes a tuberculous fistula and on what grounds are we justified in making a diagnosis? It is a discouraging task to attempt to correlate the findings of various investigators when the criteria on which the findings are based vary so greatly. There are two different methods which investigators have employed for determining a positive diagnosis: (1) that which depends on demonstration of the *Mycobacterium tuberculosis* by the inoculation of animals or by histological examination; (2) that which depends wholly on positive clinical findings. Between these two extremes are those who feel that demonstration of a certain histological picture is of diagnostic value. In addition to these factors, which partially account for the disparity in figures and diversity of opinion, is the difference in the material used for investigation. Attempts to demonstrate the tubercle bacillus in cultures made from the discharge of the ischio-rectal abscess have met with little success.

Gabriel's work proved satisfactorily that inoculation of animals is the diagnostic

## LITERATURE

- 1 DEUTSCH, ALFRED Ueber die Verwendbarkeit der Schwangerschaftsprobe Zentralbl f Gynack, 1909 53 90
- 2 DOUGELL, D M Preliminary observations on the menstrual cycle and pregnancy with a simple pregnancy diagnostic test J Clinouri M Ass 1933 30 275-277
- 3 Idem J Am M Ass 1934 103 510
- 4 FRANK C W and WARRSINGER P B Skin tests for pregnancy Am J Obst & Gynec 1933 3, 303
- 5 GERSTLISADJAK Antunovic S cutaneous test for the diagnosis of pregnancy Am J Obst & Gynec, 1933 3, 304
- 6 GILKINSON G C and CRAIG W K A new rapid economical test for pregnancy and certain gynecologic conditions Am J Obst & Gynec 1936 32 498-501
- 7 GILSKIN BENJAMIN An intradermal test for pregnancy Am J Surg, 1936 31 59
- 8 JORGES OTTO and POLLATSCHKE, R J Am M Ass 1909 93 559
- 9 SCHWITZBERG BERNARD and COHEN A E Nonspecificity of gonadotropic factor of pregnancy urine in intradermally as a test for pregnancy J Am M Ass, 1937 100 115
- 10 STRAUSS HYMAN The Porges and Pollatschek skin test for pregnancy Am J Surg 1930 8 1171
- 11 Idem J Am M Ass 1934 103 1015

a No 2 centrifuge with a head radius of 13.5 centimeters. Then the fluid was poured off and discarded and a portion of the sediment was removed, stained by methods for revealing acid-fast bacilli and studied for the presence of free tubercle bacilli. The remainder of the sediment was re-emulsified in 5 cubic centimeters of a normal saline solution. This product was placed in a refrigerator for 4 to 7 days to attenuate the colon bacillus, which is much more lethal to the guinea-pig than the staphylococcus or streptococcus. The colon bacillus also is the cause of the high proportion of failures in inoculating guinea-pigs with material taken from the lower portion of the gastro-intestinal tract.

Two guinea-pigs were given injections of material obtained from each patient, one animal being inoculated subcutaneously and the other intraperitoneally. If the guinea-pigs died and gross lesions were not evident before 3 weeks had passed, the test was considered a failure, if a guinea-pig died and lesions were not present after 3 or more weeks had elapsed, the result of the test was considered negative. If both animals were alive at the end of 4 weeks, the one receiving the intraperitoneal injection was tested by injecting 0.5 cubic centimeter of old tuberculin (O.T.) subcutaneously. If that guinea-pig died and the results of the test were positive, its mate was killed and examined. All other guinea-pigs were permitted to live for 8 weeks and, at the end of that time, were killed, and the result of the test was considered either positive or negative depending on whether lesions were present or absent.

Magath (5) has shown the importance of balancing the subcutaneously and intraperitoneally injected animals against each other. He pointed out that it is easy to understand why intraperitoneal injections should end fatally more often than subcutaneous injections, because much of the material injected contains pyogenic organisms, but, why this is true when equal amounts of the material are injected into each animal is not clear. Magath has also shown that tuberculin, although not productive of immediate death of each animal in which a positive result has been obtained, clearly

shortens the time necessary for the development of tuberculosis by about 3 weeks. In addition, Magath and Feldman (6) have demonstrated that more specimens will be found to contain the bacillus of tuberculosis by the method of injecting material into guinea-pigs than by the method of culturing the organism.

The possibility of obtaining false positive results from the inoculation of guinea-pigs may arise owing to spontaneous development of tuberculosis. Magath and Feldman have shown that when guinea-pigs are kept in cages in a room isolated from tuberculous animals and when they do not receive food from the tables of tuberculous patients and are cared for by non-tuberculous caretakers, the chances of their contracting tuberculosis is so slight that it may be ignored. Any such animal, if in normal health, may be considered suitable for experiments such as ours.

Some authors have questioned the reliability of results obtained by inoculation of guinea-pigs. Magath and Feldman stated that animals living 8 weeks after inoculation, in which gross lesions of tuberculosis have failed to develop, probably do not have tuberculosis and that the histological examination of such tissue is not necessary as a routine procedure. They concluded, after a careful study, that inoculation of guinea-pigs is a reliable means of proving the tuberculous nature of clinical material.

Fansler has expressed doubt as to the reliability of such a method when there is a focus of tuberculosis elsewhere in the body of the patient. In our series, we have avoided such error by performing repeated examinations of the sputum obtained from the patient and have compared the results of the inoculation of the guinea-pig with those of histological study. A piece of tissue almost invariably derived from the same specimen as that used for inoculation of animals was sent to the laboratory where routine pathological and histological studies were carried out.

In those cases in which the results of inoculation of animals were positive and those of routine histological study were negative, subsequent microscopic studies were made of sections cut from numerous blocks of tissue in



method which yields the most satisfactory results. He found that it is difficult to demonstrate tubercle bacilli in the tissues and he was unable to find the bacillus in any section prepared from tissue obtained from 6 patients who had been proved to have tuberculosis by the method of inoculation of animals. Moreover, in only 4 of the 75 cases which he studied did he find tubercle bacilli by using the staining method of Ziehl Neelsen.

Tuberculous ulceration of the rectum does not occur frequently. In cases of fistula in ano, the tubercle bacillus gains entrance to the perianal tissues through a diseased crypt. The pathological characteristics of the tuberculous anal fistula are similar to those of tuberculosis elsewhere in the body excepting those changes which accompany secondary infection and trauma. Frequently, the attempt to make a clinical diagnosis or one based on the gross pathological characteristics of such a lesion is an error. The majority of such diagnoses are based on the appearance of the secondary, or external, openings. The appearance of the secondary opening may vary greatly, depending on the duration of the disease.

#### ROUTES OF INFECTION

In general, it is thought that there are four routes by which tubercle bacilli may gain access to the anorectal region.

*Extension of infection from the lumen of the bowel.* This is probably the usual route. The organisms gain entrance to the intestinal canal after they have been swallowed in the sputum. Tubercle bacilli, having passed through the digestive canal in this way, rarely produce tuberculosis in the anorectal region. Although tuberculosis of the intestine and rectum do occur and although tubercle bacilli are often found in feces, anorectal tuberculosis does not develop in the majority of the cases of pulmonary tuberculosis.

*Transportation of organisms by the blood stream.* According to this theory, tubercle bacilli are carried in the blood stream from some focus and are lodged in the submucous layer of the rectum and in the fat of the ischioanal fossa.

*Direct external inoculation.* Patients suffer from active pulmonary tuberculosis may

contaminate the anus, especially if an abrasion is present. This may result in direct inoculation of the abrasion with *Mycobacterium tuberculosis*.

*Direct extension.* Tuberculosis of the female genital organs, of the prostate gland or the seminal vesicles may produce a fistula which has an external opening near the anus. Similarly, tuberculosis of the sacrum, coccyx, or pelvic bones may involve the perirectal tissues and produce fistulas similar to anal fistulas.

Anal fistulas originate from infected anal crypts and rarely is the primary opening of such a fistula found elsewhere. In only 2 of the cases presented in this report was there an associated condition which suggested the possibility that tubercle bacilli had gained access to the ischioanal or ischioanal tissues through avenues other than the crypts of Morgagni. Probably the most frequently offending organism in cases of ischioanal abscess is the colon bacillus.

Is the *Mycobacterium tuberculosis* a primary or secondary invader? It seems reasonable to regard tuberculous ischioanal conditions in the same light as tuberculous conditions of the thoracic wall. Primary tuberculous abscess of the thoracic wall is practically unknown.

#### METHOD OF STUDY

This investigation is based on 206 consecutive cases in which operation was performed for anal fistula. In addition to recording the patient's history and performing a physical examination, a roentgenological examination of the chest and routine laboratory tests of urine were carried out. Flocculation tests, determination of the concentration of hemoglobin, and of the number of erythrocytes and leucocytes also were performed. At the time of operation the surgeon paid particular attention to the selection of tissue that was to be subjected to examination and analysis.

Part of the selected tissue was prepared for inoculation into guinea pigs in the following manner. The tissue was finely divided by grinding and mixing with sand in a mortar. With this 5 cubic centimeters of normal saline solution was thoroughly mixed. The supernatant fluid was poured off and centrifuged for one hour at 2500 revolutions per minute in

TABLE I — SUMMARY OF A STUDY OF ANORECTAL FISTULA WITH REGARD TO ITS TUBERCULOUS NATURE—206 CONSECUTIVE CASES

	Cases	Per cent of cases successfully studied	Per cent total positive animal inoculations
Inoculation failed	11*		
Successfully studied	195†		
Negative in all respects for tuberculosis	163	83.6	
Evidence of tuberculosis somewhere in body	32	16.4	
Evidence of tuberculous "focus" but inoculation and histopathological examination negative	10	5.1	
Animal inoculation positive	22	11.3	
Organism demonstrated by Ziehl-Neelsen stain	3	1.5	13.6
Evidence of tuberculous "focus"			
Positive	17	8.7	77.3
Negative	5	2.5	22.7
Histopathological examination			
Routine positive	8	4.1	
Subsequent positive	5	2.5	22.7
Subsequent negative	9	4.6	41.8

\*5.3% of total cases 19.4% of total cases

tuberculosis could not be found microscopically. Frequently, foreign body giant cells are found in sections of tissue from anorectal fistulas and are sometimes confused with anatomic tubercle.

Ziehl-Neelsen staining technique was carried out on sections of tissue derived from all cases in which the result of inoculation of animals was positive and the bacillus of tuberculosis was identified in 3 cases (1.5 per cent of the total group or 13.6 per cent of the cases in which positive results were obtained on inoculation of animals).

Of the 22 patients who were proved to have a tuberculous fistula, 17 (87 per cent of those successfully studied and 77.3 per cent of those in which positive results were obtained by inoculation of animals) were shown to have, in addition, a so called focus of tuberculosis elsewhere in the body (9 cases of active pulmonary tuberculosis and 8 cases of a healed lesion in the lungs). In the 5 remaining cases of tuberculous fistula (2.5 per cent of those successfully studied and 22.7 per cent of those in which positive results were obtained by inoculation of animals), evidence of a "focus" of tuberculosis could not be found. In

1 of the 5 cases the organism was demonstrated in sections of tissue taken from the fistula.

Healing of the wound in cases of surgically treated tuberculous fistula is definitely prolonged. In the 22 cases in which positive results were obtained, the average time required for healing was 73 days as compared with an average of 29 days in the 173 cases of non-tuberculous fistula. Whether a fistula is tuberculous or not should not alter the type of treatment employed.

## CONCLUSIONS

1. Inoculation of animals by the method described is the most accurate way of determining the tuberculous or non-tuberculous nature of an anorectal fistula.

2. In this series, positive results were obtained in 11.3 per cent of cases. Routine and also subsequent microscopic study of many sections of tissue proved that tuberculosis was present in only 6.6 per cent of the cases.

3. A tuberculous focus was present in 77.3 per cent of the cases of tuberculous fistula.

4. If pulmonary tuberculosis and anorectal fistula co-exist, the tuberculous nature of the fistula can be strongly suspected.

5. The co-existence of a focus of tuberculosis and non-tuberculous fistula occurred in 5.1 per cent of this series of cases.

6. Healing of the wound after operation is slower in cases of tuberculous fistulas than it is in those cases of non-tuberculous fistulas but healing should always be complete if the operation has been performed properly and if the wound has been dealt with adequately.

## REFERENCES

1. BUTE, L. A. Ancient and modern knowledge concerning anal fistula. *Med Ann Dist Columbia*, 1936, 5: 123.
2. FANSLER, W. A. The relationship of tuberculosis to fistula in ano. *J Am M Ass*, 1925, 85: 671-673.
3. GABRIEL, W. B. Results of an experimental and histological investigation into seventy-five cases of rectal fistulae. pp 154-161. *Collected Papers of St Mark's Hospital*. London: H. K. Lewis & Co., Ltd., 1935.
4. HEURTELoup. Quoted by Freeman, Leonard. In Klebs, A. C. *Tuberculosis*. p. 768. New York: D. Appleton & Co., 1909.
5. MAGATH, T. B. Large doses of tuberculin in testing guinea pigs inoculated for diagnostic purposes. *Am J M Sc*, 1934, 188: 403-409.
6. MAGATH, T. B., and FELDMAN, W. H. The relative value of cultural methods and guinea pig inoculation in the diagnosis of tuberculosis. *Am J Clin Path*, (May) 1932, 2: 199-228.



Fig 1 Tubercle bacillus in tissue adjacent to fistulous tract  $\times 97$

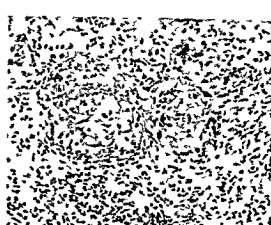


Fig 2 Tubercles containing epithelioid cells surrounded by a zone of lymphocytic infiltration  $\times 90$

an effort to compare the results of histological study with those of inoculation of animals.

The staining technique of Ziehl Neelsen was used on sections of tissue in all cases in which the result of inoculation of the animal was positive.

#### RESULTS

In this study of 206 consecutive cases of anorectal fistula (Table I) there were 11 (5.3 per cent) in which both the animals that received subcutaneous injections and those that received intraperitoneal injections died before the aforementioned time limit had expired. This low percentage of failures can probably be accounted for by the fact that a method of attenuation of the colon bacillus was employed. More deaths occurred before the time limit expired in the cases of those guinea pigs injected intraperitoneally than occurred after the time limit had expired. However, as Magath has previously pointed out, a larger number of positive results are to be expected from the intraperitoneal method of injection than from the subcutaneous method of injection.

One hundred and ninety-five cases (94.7 per cent of the total group) were studied successfully and completely. Of these, evidence of the presence of tuberculosis was not found in 163 cases (83.6 per cent). In 32 cases (16.4 per cent) we were able to find evidence of the presence of tuberculosis somewhere in the body.

Of this group of 32 cases, 10 (5.1 per cent of total cases) gave evidence of a tuberculous "focus," that is, 7 of the patients had healed or inactive pulmonary tuberculosis, 2 had an active pulmonary lesion and 1 had tuberculosis of the cervical lymph nodes. Inoculation of animals, routine histopathological studies and subsequent study of numerous sections of tissue did not reveal evidence of tuberculosis in the anorectal fistula.

Inoculation of animals gave positive results in 22 cases (11.3 per cent of those successfully studied) whereas routine histological study of sections from an adjacent piece of fistulous tissue gave positive results in only 8 cases (4.1 per cent). These results approach closely those of other investigators who have used the same method of studying sections of a similar nature. If we had relied on routine histopathological study only, we would have missed the diagnosis in 63.6 per cent of the cases. In a subsequent study of numerous sections of tissue derived from those cases in which the diagnosis based on the results of inoculation of animals did not coincide with that based on routine histopathological examination we were able to demonstrate the presence of the tubercle in 5 additional cases (Figs. 1 and 2). There were, therefore, 13 cases (6.6 per cent of total cases) in which the results of inoculation of animals coincided with those of microscopic study, whereas in the remaining 9 cases (4.8 per cent of positive results) evidence of

# CLINICAL SURGERY

FROM THE MANCHESTER ROYAL INFIRMARY

## A MODIFIED SCHOEMAKER GASTRECTOMY FOR CHRONIC GASTRIC ULCER

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**I**N 1921, J. Schoemaker of the Hague described in *SURGERY, GYNECOLOGY AND OBSTETRICS* a modification of the original Billroth I gastrectomy that appeared to the present writer to obviate most of the difficulties and dangers of that operation.

After an extended trial of Schoemaker's operation it was realized that his original two bladed crushing clamp was often difficult to apply and prone to slip off the stomach when it had been applied, and in consequence a clamp of different type, that could be applied from the upper or lesser curvature aspect of the stomach, was designed for me by Dr K. B. Pinson, anesthetist to the Manchester Royal Infirmary.

The operation now to be described has been found to be superior to the Pólya-Balfour gastrectomy in cases of chronic gastric ulcer in that it is less likely to be followed by severe anemia, since some gastric function is preserved, while it involves no greater risk of anastomotic ulcer. In cases of duodenal ulcer with pronounced hyperchlorhydria, or in gastrojejunal ulcer, the more destructive Pólya-Balfour operation is preferred.

### PREPARATION FOR OPERATION

The first essential is to see that dental sepsis is eradicated, and that the patient is provided with an efficient supply of teeth, natural or artificial, for the purpose of mastication.

When the roentgenographic examination shows appreciable delay in emptying, as is so commonly found in large prepyloric ulcers, gastric lavage for a few days, repeated on the morning of operation, is advisable. In cases of marked anemia from gross or continued occult hemorrhage, an intensive pre-operative course of iron is essential.

### THE ANESTHETIC

While some surgeons are strong advocates of a combination of local and splanchnic anesthesia, we have found that basal anesthesia with avertin,

followed by gas and oxygen with some ether, is less trying to the patient and the surgeon, less time-consuming, and no more dangerous as regards postoperative complications. The services of a really expert anesthetist are, of course, essential.

### THE OPERATION

A right paramedian incision extending from the costal margin to a little below the umbilicus, is usually preferred, as it gives a stronger scar and affords the best access to the duodenum. The edges of the wound are then protected by gauze swabs. After a general inspection of the abdominal viscera, including the stomach and duodenum, the thin lesser omentum is torn through above the prepyloric portion of the stomach and a hand is inserted into the lesser sac of the peritoneum to separate the filmy congenital adhesions so constantly found between the stomach and the transverse mesocolon or colon. The pyloric vessels immediately above the first part of the duodenum are then clamped between two artery forceps, divided and ligatured with linen thread. The gastroduodenal ligament is next divided between forceps, beginning just below the pylorus and working as far to the left as the point at which it is decided to divide the stomach. All the lower divided vessels are then tied, those on the upper or gastric side being left in the grip of the artery forceps. The line of this division may be carried immediately below the greater curvature of the stomach and above the gastro-epiploic vessels, or between the gastro-epiploic vessels and the transverse colon, in which case the right gastro-epiploic artery is divided below the pyloric antrum. While the former method has the theoretical advantage that it preserves the blood supply of the dependent portion of the omentum, it involves the ligation of many more vessels than the latter. We prefer to divide the omentum below the gastro-epiploic vessels on this account and have found no ill effects upon the omentum in practice. The

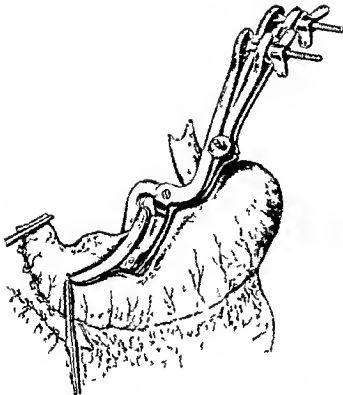
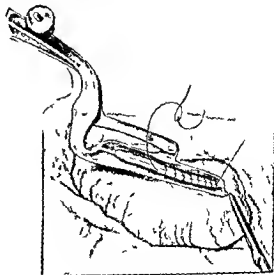


Fig. 5 Method of applying the author's crushing clamp. The duodenum has been divided between clamps and the crushing clamp and a Schoemaker colectomy for ectopy are applied to the stomach. Note. Considerably more of the stomach is usually removed than this illustration depicts.

Fig. 6 One blade of the crushing clamp has been removed and the continuous hemostatic suture along the new lesser curvature is being inserted.



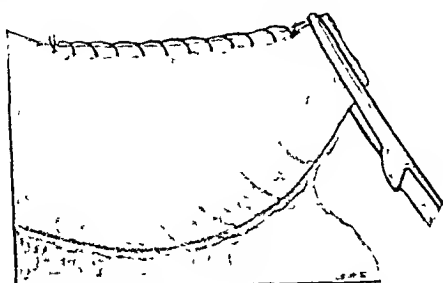


Fig 4 The new lesser curvature on completion of the suture, viewed from behind

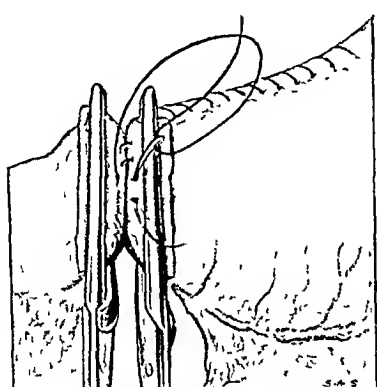


Fig 5 End-to-end union of stomach and duodenum, commencement of posterior row of sutures

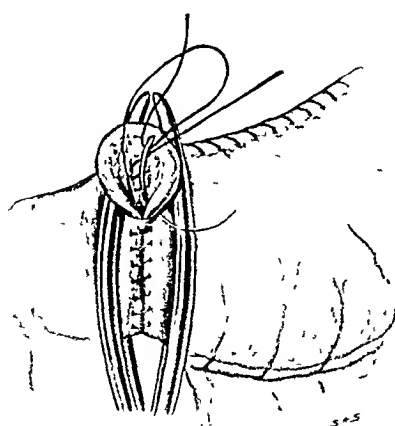


Fig 7 End-to-end union of stomach and duodenum, hemostatic suture is shown nearing completion For the sake of clearness the uncompleted seromuscular suture is not shown

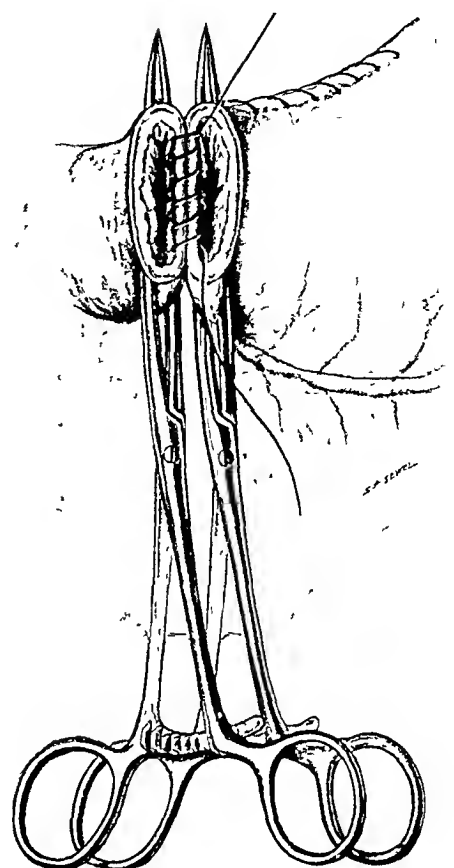


Fig 6 End-to-end union of stomach and duodenum, commencement of continuous hemostatic suture For the sake of clearness the posterior half of the seromuscular suture is not shown

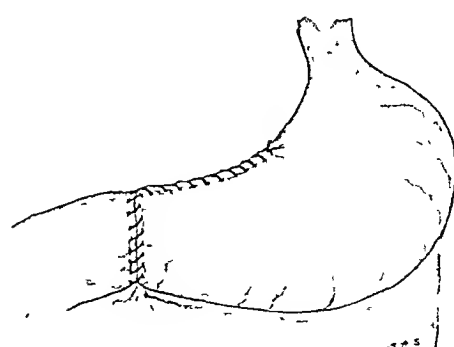


Fig 8 The operation completed Note the normal form of the stomach

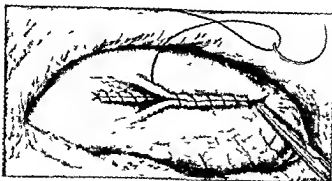


Fig 3 Application of the invaginating seromuscular suture along the new lesser curvature

left gastro epiploic vessels are clamped, divided, and tied at a point as far to the left as is necessary. The next step is the division of the first part of the duodenum. Two Schoemaker colectomy clamps with grooved blades are applied side by side across the duodenum immediately distal to the pyloric sphincter and the duodenum is divided between them with a knife. The cut ends of the duodenum held by the two clamps are cleaned with moist swabs. The distal clamp is left covered by a large gauze swab and the proximal clamp is protected by a small gauze swab clamped over it by two Lane's tissue forceps. These forceps not only prevent any risk that the Schoemaker clamp may slip but are convenient in exerting traction on the stomach.

The stomach is now lifted up and to the left and any adhesions between the ulcer and the pancreas are divided. When the ulcer is not penetrating the pancreas this division is carried out with the knife. In large ulcers that have invaded the pancreas deeply however it is unsafe to cut into the pancreas on account of the risk of subsequent leakage of pancreatic juice. In such cases the edges of the ulcer are stripped off the pancreas with the fingers regardless of the fact that the lumen of the stomach is opened. Swabs are placed round before this maneuver and a sucker is inserted into the stomach to empty it of any fluid contents. The line of cleavage where the ulcer is stripped off the pancreas is avascular and does not bleed.

Having freed the ulcer from its posterior adhesions the left gastric (coronary) artery in the gastrohepatic omentum is divided between clamps. This is done a short distance above the ulcer on the lesser curvature. A hole is made between the lesser curvature of the stomach and the lesser omentum and three curved artery for-

ceps are applied to the upper part of the lesser omentum through this hole so as to grasp the left gastric artery. The omentum and artery are divided by curved scissors, two of the artery forceps being left on the proximal part of the artery and one on the distal part. The proximal end is then doubly ligatured with No. 60 linen thread and the distal end is also tied.

The stomach is now drawn downward and out of the wound and the point on the greater curvature destined for anastomosis with the duodenum is determined. Here a Schoemaker colectomy clamp is applied at a right angle to the greater curvature, with care to include as much of the transverse section of the stomach in its grip as will correspond with the width of the duodenum.

While an assistant draws the stomach firmly downward and also exerts some downward traction on the colectomy clamp that grasps the greater curvature of the stomach the curved Pinson crushing clamp is applied to the stomach from the lesser curvature above the ulcer a little obliquely so that the tip of its blades touches the tip of the small colectomy clamp (Fig 1). A straight or curved gastro-enterostomy clamp is now placed across the stomach distal to these two clamps to prevent escape of contents and the stomach is divided with a knife flush with the two proximal clamps and its distal portion is removed.

The next step is closure of that part of the stomach in the grip of the large two bladed crushing clamp to form what is to be the new lower portion of the lesser curvature. The outer blade of the crushing clamp is removed leaving a flail of crushed stomach wall projecting from the inner blade. This stomach wall is sutured with a continuous stitch of No. 00 catgut (20 day) starting at the tip of the blade and working up to the lesser curvature (Fig 2). The second blade of the

# SUPRACONDYLAR FRACTURE OF THE HUMERUS

## An Analysis of 330 Cases

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THE purpose of this paper is the review of the results of treatment of 330 cases of supracondylar fractures of the humerus which have been seen on the Children's Surgical Service of Bellevue Hospital during the past 18 years. The 109 cases of supracondylar fracture that were reported in 1925 (8) are included in this report. Certain fundamental problems presented themselves in the management of these cases which will be discussed in this paper. A method of reduction and fixation is described so as to prevent deviation of the axis of the forearm. It is not the purpose to review the literature of supracondylar fracture but rather to present the salient clinical problems which have been encountered in the treatment of these cases.

Supracondylar fracture is a distinct entity having little in common with fractures in other parts of the body. This is particularly so for the following reasons: first, because of the close proximity of the fracture to the intricate articular surface of the elbow joint, second, the effect that the displacement of the fragments may have on the neurovascular structures passing over the joint, third, the possible permanent deviation of the axis of the forearm that may result from (a) an injury to the cartilage plate of one of the epiphyses, or (b) a failure to obtain a correct alignment of the distal fragment of a supracondylar fracture.

### END-RESULTS

Of the 330 cases of supracondylar fractures treated, 292 (89 per cent) of the patients were followed from 2 months to as long as 14 years, and 38 were lost.

The factors which were considered in evaluating the results, are (1) restoration of function, (2) deformity, and (3) residual complications.

1. *Restoration of function.* Of the 292 cases, 236 (81 per cent) had almost complete restoration of function. Of the 56 remaining cases (19 per cent), 4, complicated by threatened ischemic paralysis, have not regained complete function, and in 52 others (18 per cent) the functional recovery is protracted and the patients are under treatment.

From the Children's Surgical Service, Bellevue Hospital, Fenwick Beekman, M D., in charge

2. *Deformity.* There were 44 of the 236 cases which regained function, and in these cases there was deviation of the axis of the forearm, 26 having a loss in the carrying angle, 8 with a glaring *gunstock deformity*. In 2 cases the deformity has been corrected by a cuneiform osteotomy. Nineteen fractures healed with a perceptible increase in the outward angulation of the forearm. It is significant that the reparative process in children due to growth often corrects a deformity caused by a vicious union but does not always restore the normal carrying angle. In this series vicious union rarely permanently impaired function, while an unreduced lateral or mesial fracture or rotation of the distal fragment invariably altered the carrying angle.

3. *Residual complications.* There were 20 cases of muscular spasm and 7 of myositis ossificans. Both of these complications followed fractures about the elbow which were recorded in my previous paper. In the case of the 221 patients with supracondylar fracture which have been treated since 1924, when the former series was reported, there has been no case of either muscular spasm or myositis ossificans. In but 1 of the 9 cases which showed evidence of an impending Volkmann's ischemic paralysis did ischemia develop. Seven children had symptoms referable to injury of the deep muscular branch of the radial nerve and 4 of the ulnar nerve. Whether this resulted from a displaced fragment or excessive callus formation accompanying vicious union is uncertain, but it is interesting to note that the symptoms in all of these cases of nerve injury have disappeared as a result of the absorption of the excessive callus. No case of delayed ulnar neuritis has come under our observation as yet in this series.

The following classification has been adhered to in the analysis of the end-results

Excellent	—Complete function with a normal carrying angle
Good	—Complete function with a slight increase in the carrying angle
Fair	—Complete function with a 5 per cent loss of carrying angle
	—Limitation of less than 25 per cent flexion with a straight or normal axis of the forearm



clamp is now removed, and a continuous seromuscular suture of catgut is inserted so as to invaginate the former or through and through suture (Figs 3 and 4)

The two small colectomy clamps, one on the duodenum and one on the greater curvature of the stomach, can now be approximated with the greatest of ease for the end to-end anastomosis of the stomach with the duodenum. The posterior part of the continuous seromuscular catgut suture is begun at the lesser curvature aspect. A curved needle is used and it is inserted parallel with the clamps (Fig 5). When the greater curvature is reached, the suture is knotted and laid aside.

Before the colectomy clamps occluding the stomach and duodenum are removed these organs are secured by two gastro-enterostomy clamps placed one inch above and below the line of anastomosis. The occluding clamps are now removed and the continuous through and through catgut suture is inserted again on a curved needle (Figs 6 and 7).

The seromuscular suture is next completed by carrying it along the anterior surface of the suture line up to the point at the lesser curvature where it started. After the circle is completed and the suture is tied two further sutures are inserted to guard the 'dangerous angle' on the lesser curvature from tension. We have never known leakage to occur at this or any other point.

In performing this end to end anastomosis it is important to make sure that no stenosis results. The finger and thumb should be able to meet readily when invaginating the anastomosis from without at completion of the operation (Fig 8).

One point in the application of the crushing clamp requires emphasis. The clamp should never be applied too obliquely so as to make the

new prepyloric portion of the stomach too slender and funnel shaped. In earlier cases in which this was done, some disturbing postoperative vomiting occurred for the first few days. When the clamp is applied as it should be almost transversely to the stomach, the postoperative course is usually free from vomiting. The abdominal wound is closed in layers in the usual way and a dressing applied.

#### POSTOPERATIVE TREATMENT

Morphia and atropine and rectal saline infusions are given for the first 24 hours. Intravenous saline by the continuous drip method is reserved for cases suffering from pre-operative anemia or for those rare patients who develop symptoms of postoperative shock. Fluids sufficient to allay thirst are allowed from the first. A daily enema is given from the second day until the end of the first week. No solid food is allowed until a week from the operation has elapsed. The postoperative course is usually smoother than that after a simple gastro-enterostomy in that there is less tendency to vomiting.

#### MORTALITY RATE

In a consecutive series of 190 cases of Stroe maker gastrectomy for chronic gastric ulcer in which patients were operated upon by the writer, there have been 5 deaths a mortality of 2.6 per cent. This is little above the mortality of gastro-enterostomy for simple ulcer and compares favorably with the mortality of the Balfour Polya operation in the same type of case, which has been 6.4 per cent in my hands.

I am indebted to the publishers of the *British Journal of Surgery* for the loan of the illustrations. These drawings were reproduced to appear in an article on 'The Technique and Results of Partial Gastrectomy for Chronic Gastric Ulcer' 19 8 16 239-5.

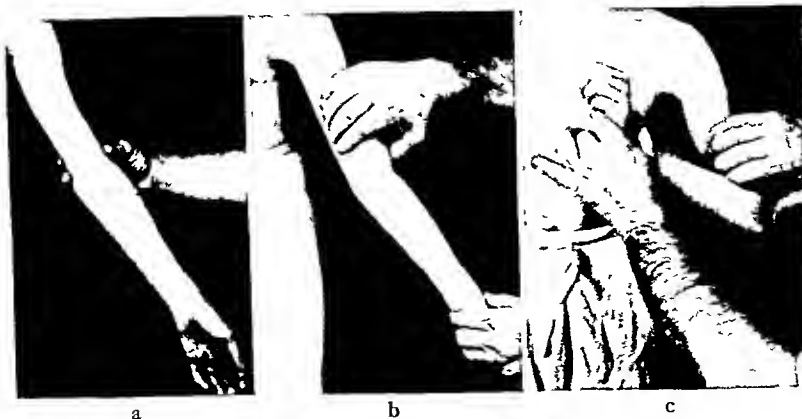


Fig 2 a, b, c, Steps in procedure for reducing the lateral or mesial and posterior displacement of the distal fragment

fragment can still be seen to project obliquely forward

The stripping of the periosteum from the distal end of the upper fragment can be demonstrated by means of a lateral view as early as the seventh day after the fracture in practically every case in which the fracture has not been completely reduced. Ordinarily the stripped periosteum which is firmly attached to the displaced lower fragment is not visualized, for only after the deposition of calcium in the callus can the new shaft be discerned within the confines of the stripped periosteum

#### DISPLACEMENT OF FRAGMENTS

Supracondylar fracture continues to be the most frequently encountered elbow injury on the Children's Surgical Service at Bellevue Hospital. In all the cases in which the distal fragment was displaced posteriorly, the trauma producing the injury was from a fall on the outstretched hand. The displacement resulted in a stripping of the periosteum from the distal end of the proximal fragment due to its firm attachment to the distal fragment. This was first noted by Poland in 1898, who drew attention to it as an important factor in the production of callus. This stripping of the periosteum plays an important part in limiting the displacement of the fragment and in subsequent healing, particularly when complete reduction has not been obtained. This may be demonstrated in 3 to 6 weeks' time by means of a roentgenogram, which then shows evidence of new bone springing from the displaced lower fragment and along the reflected periosteum.

In 72 cases (22 per cent) there was no displacement of the lower fragment. Of the 244 cases

(74 per cent), in which complete *posterior* displacement of the lower fragment was present, 162 had no appreciable lateral or mesial displacement, in 44 the lower fragment was displaced backward and inward and in 38 backward and outward. The lower fragment was displaced *anteriorly* in but 14 cases (4 per cent) all of which fractures were sustained through direct violence.

There were 232 fractures in which the line of fracture was transverse and 98 in which it was oblique. With the few exceptions in the case of oblique fractures the distal end of the proximal fragment was displaced into the antecubital space. Of the 330 fractures 33 were comminuted. Thirty-two extended into the external condyle, 39 into the internal condyle, and 21 through one of the epiphyseal cartilage plates.

In two of the comminuted fractures the articular fragment was split, a consequence of muscle contraction which forces the upper fragment between the lower fragments, thus distorting the elbow joint.

#### TREATMENT

There are four important objectives to bear in mind in the treatment of a supracondylar fracture. First and foremost is the prevention of a Volkmann's paralysis, second, a satisfactory reduction, third, the prevention of a varus or valgus deformity, and fourth, the restoration of function. All four objectives are dependent on obtaining a good alignment of the fragments. Permitting the malposition of the fragments to remain until the swelling has subsided is unreasonable. Such a procedure necessitates a difficult and prolonged course of treatment and a defeat in one or more of the objectives. The malposition should



Fig. 1 Typical supracondylar deformity with posterior displacement of the distal fragment

- |      |  |
|------|--|
| Poor | —Complete function and an obvious gun stock deformity                  |
|      | —Limitation of less than 5 per cent extension and flexion of the elbow |
| Bad  | —More than 25 per cent limitation of function                          |
|      | —Volkmann's ischemic paralysis   |
|      | —Ankylosis   |

Of the 292 cases followed, in 168 (58 per cent) the results can be said to be excellent, 30 (10 per cent), good, 69 (24 per cent), fair, 15 (5 per cent), poor, and 10 (3 per cent), bad. These results include the 52 cases (18 per cent) in which patients are under treatment, and in many of them there will be improvement in function and the cases therefore deserve better classification.

#### AGE INCIDENCE

It is significant that the largest number of cases occurred during the sixth year and that between the ages of 5 and 7 there were 16 (49 per cent). This being almost equal to the combined number of fractures occurring in the 9 remaining age groups of this series. The incidence of frequency in the various age groups appears to decrease both toward earlier childhood and the advancing years.

#### CLINICAL EXAMINATION

Of the 258 supracondylar fractures with displacement, the distortion from swelling increased perceptibly in proportion to the delay supervening between the time of injury and that of reduction (Fig. 1). In many of these the lower end of

the anteriorly displaced upper fragment could readily be palpated beneath the skin. The break in the continuity of the humerus could often be palpated posteriorly. Due to this displacement and the extravasation of blood in the antecubital space, there was often much tension of the overlying skin which at times was followed by the formation of blebs. In most of the cases the forearm assumed a position of complete pronation with approximately 140 degrees of extension at the elbow joint. When the fragments were completely displaced there was always an increase in the anterior posterior diameter of the arm.

When there was overriding measurements taken from the tip of the acromial process to the lateral epicondyle revealed an appreciable shortening as compared with the other arm. In none of these cases was there any disturbance in the relation between the three bony prominences of the elbow; this finding was indispensable in eliminating a posterior dislocation of the radius and ulna. The presence or absence of neurovascular injury should be noted before any attempt is made to reduce the fracture so as to obviate a later question of such complications having resulted from the manipulation. There were 12 compound fractures in this series, which are detailed elsewhere.

#### ROENTGENOGRAPHIC EXAMINATION

Roentgenographic examination should determine not only the extent of the displacement of the lower fragment but also whether there is an extension of the fracture line through the epiphyseal cartilage plate of either of the condyles. The amount of serration or spurring of the fracture surface should be noted, because of its influence upon attempts at reduction.

What at first appearance may seem to be a transverse fracture will occasionally be found to be a fracture line which extends obliquely downward and forward. This is the type of fracture that is so difficult to maintain in position after reduction. It is important to note the amount of lateral or mesial displacement of the lower fragment as failure to recognize and correct this displacement will result in a varus or valgus deformity.

A lateral view will reveal the amount of anterior displacement of the upper fragment. The relationship of the distal fragment and the forearm which are one to the upper fragment in regard to the amount of rotation of the lower fragment, is often demonstrable in this view. The significance of the rotation of the lower fragment on the upper is appreciated after the posterior displacement has been reduced when the upper



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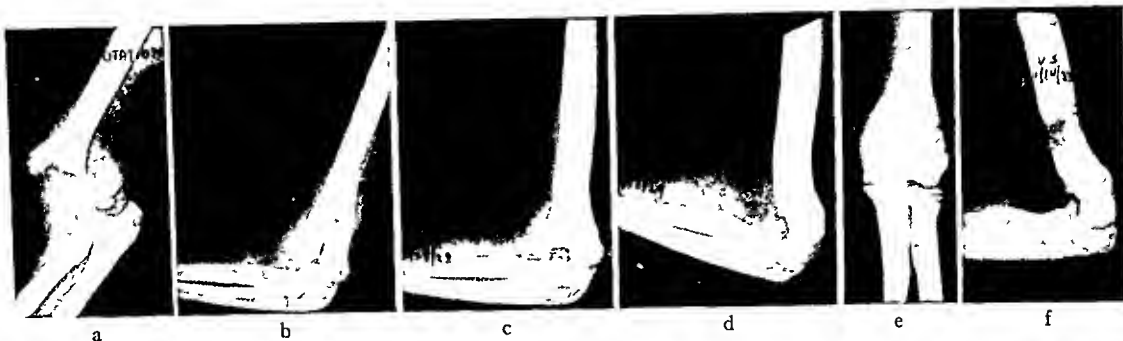


Fig 5

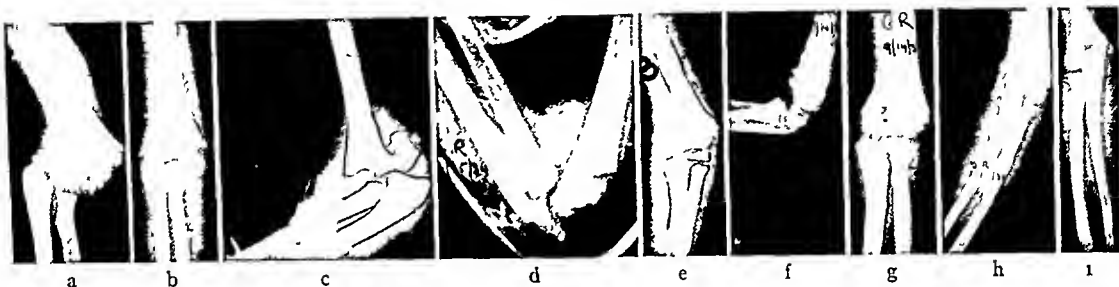


Fig 6

Fig 5 V S, 5 years old On May 7, 1927, patient fell on his left elbow and sustained a supracondylar fracture of the humerus Under an anesthetic and with the aid of the fluoroscope, an attempt was made to reduce the fragments and the elbow was immobilized with plaster splints in acute flexion The radial pulse became obliterated and the fingers began to swell The forearm was then suspended by means of adhesive at right angles to the elbow, and this was followed by a return in pulsation a, Persistent rotation and forward displacement of the proximal fragment accounting for the pressure on the neurovascular structures and the obliteration of the radial pulse b, c, and d, Taken June 10, 1927, January 21, 1928, and September 7, 1929 respectively These photographs show the persistent posterior displacement of the lower fragment with the periosteum stripped off the posterior aspect of the proximal fragment, with the gradual absorption and recession of the anterior displaced proximal fragment as the distal fragment continues to grow downward e and f, Taken January 14, 1933, shows the contour of the shaft of the humerus assuming a normal appearance At this time the function and carrying angle was normal

Fig 6 G R, aged 9 years, sustained a supracondylar fracture of the left humerus on August 1, 1934 a and b, Taken August 4, 1934, show marked posterior and mesial displacement of the distal fragment c, August 8, 1934, persistent displacement after second attempt at reduction still evident d, August 15, 1934, a satisfactory reduction of the posterior displacement is shown after the third attempt e, September 6, 1934, the mesial displacement of the distal fragment has not been completely replaced f, September 14, 1934, satisfactory reduction of the posterior displacement with some periosteal stripping



Fig 6 j

g, persistence of mesial displacement of distal fragment with extensive reparative process under stripped periosteum h and i, October 10, 1936, continued downward growth of lateral aspect of the lower end of the humerus resulting in a varus deformity as contrasted with the normal elbow j, Photograph, November 20, 1937, showing the varus deformity The function of the elbow is unimpaired

*Reducing the posterior displacement of the distal fragment. (x) Correction of the lateral or mesial displacement is equally as important as the*

*reduction of the posterior Gentle pressure with the thumb and index finger on both sides of the fragments aligns the ends of the bone in the proper*





Fig 11 R Q 7 years old a, June 23 1931, impaction and forward angulation of both fragments b, Note slight lateral displacement of the distal fragment Reduction was unsuccessful and when the elbow was immobilized in acute flexion in plaster molded splints, the radial pulse became obliterated and the fingers began to swell The splints were removed and the forearm was suspended at right angles to the elbow This was followed by a restoration of the radial pulsation c, July 13, 1931, correction of the lateral displacement of the distal fragment is shown d, July 13, 1931, lateral view Note persistent backward displacement of the distal fragment with periosteal stripping and vicious union with evidence of a new shaft forming e, November 23, 1932, lateral view Note recession of protruding upper fragment and extent of reparative process in 7 months f, November 23, 1932, anterior view An appreciable downward growth of the mesial aspect of the lower end of the humerus with a deviation of the axis of the forearm is revealed Junction of the elbow was entirely regained but there was a perceptible increase in the carrying angle

of the upper fragment, hyperextension of the elbow is brought about by traction upon the patient's pronated wrist with the surgeon's left hand while the operator's right thumb exerts downward and forward pressure on the posterior aspect of the lower fragment simultaneously as pressure is exerted on the anterior aspect of the upper fragment by the four fingers of the surgeon's right hand (Fig 2b) This maneuver results in the distal fragment gliding under the proximal With the thumb and four fingers of the right hand maintaining pressure upon the lower and upper fragments respectively, the patient's forearm is brought into a position of *acute flexion and the forearm is semipronated* (Fig 2c) The position of the fragments is now checked by means of the fluoroscope

If a fluoroscope is not available, lateral and anteroposterior roentgenograms should be obtained before the retentive dressing is applied These maneuvers should be repeated if a satisfactory reduction of the fragments has not been obtained The use of force during manipulation is contra-indicated lest the serrations upon the ends of the fragments be destroyed or damage be inflicted to the soft parts

What constitutes a *satisfactory reduction*? Obviously a normal re-alignment means a satisfactory position of the fragments, this should result in an early functional recovery without deformity (Fig 3, Case L K—a, b, c, d, e)

A partial reduction of a posteriorly displaced lower fragment is satisfactory provided the rotation has been corrected and there is no mesial or lateral displacement. For example, in the case of

L C (Fig 4 a, b, c, d), the displaced lower fragment became the base of the new shaft as the reparative process developed within the confines of the periosteum which had been stripped off the posterior aspect of the upper fragment and the end of the anterior displaced upper fragment became absorbed and receded as the lower fragment continued to grow downward In this way the contour of the shaft of the humerus assumed a normal appearance, there was no deviation of carrying angle, and functional recovery was restored with no disability

A persistent overriding or a lateral or mesial displacement must be considered as unsatisfac-



Fig 12 Skeletal traction The Kirschner wire is inserted through the base of the olecranon process, distal to the epiphysis Balanced traction is made with the forearm in a position of flexion and semipronation





Fig 7 Immobilization in molded plaster splints a Flexion and semipronation with crescentic opening for palpation of radial pulse b Splints bandaged and forearm across the chest Sling is omitted to show the unplastered wrist to permit access to the radial pulse

long axis of the humerus (Fig 2a) Failure to recognize and reduce the lateral or mesial displacement will result in a varus or valgus deformity for which even the extraordinary reparative process, due to the growth of bone, will often fail to compensate Too much emphasis, therefore cannot be placed on the importance of correcting the lateral slide even though the posterior displacement has been reduced

If the fragments are *partially impacted* and there is a *lateral displacement*, the impaction should be broken up by means of *rocking* the fragments Rocking has been used by the writer for many years for breaking up impactions

(2) The posterior displacement of the lower fragment is corrected by means of hyperextending the elbow and exerting a downward pressure on the lower fragment as advocated by Lusk then the elbow is flexed as recommended by Jones and the forearm is pronated as suggested by Boehler



Fig 9 C II a Myositis ossificans resulting from kneading massage b Three years after discontinuing massage

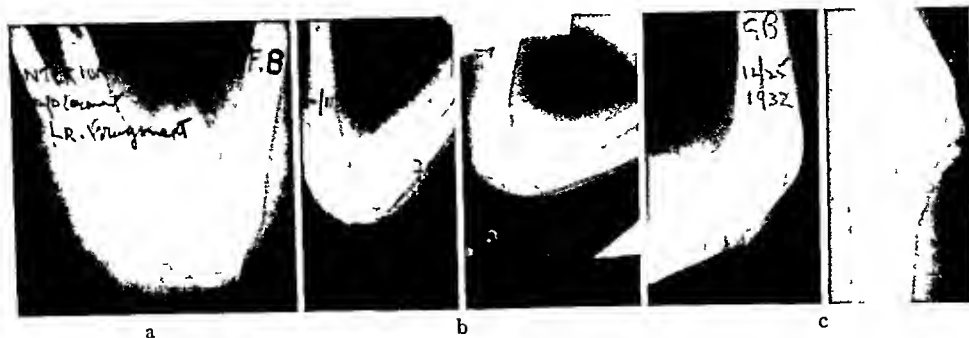


Fig 8 Non-constricting adhesive fixation dressing with the forearm flexed and in semipronation a A wide strip of adhesive is placed on the ulnar side of the volar surface of the forearm close to the wrist extending behind the mesial aspect of the semipronated forearm along the outer side and back of the arm close to the axilla and over several layers of gauze which extends above and below the adhesive b The adhesive is continued over the inner side of the arm and forearm (Note that the radial half of the forearm and part of the arm are not covered with adhesive that is there is no encircling dressing and access to the radial pulse is easy c A thinly padded bass wood splint is applied to the back of the forearm beginning from the metacarpal phalangeal junction to the elbow to prevent a pseudo wrist drop The forearm rests across the chest and is suspended from the neck by a sling which is loosely tied about the wrist so as to avoid constriction

These principles for reduction and fixation and the rocking of the elbow to correct the lateral displacement of the fragments are carried out in the following manner Rocking is accomplished by grasping the pronated wrist and raising the forearm the elbow is then rocked in all directions This procedure invariably unlocks any impaction and with the aid of a little pressure the fragments become aligned in their long axis To obtain reduction of a fracture of the left arm the surgeon stands to the left of the patient and with his left hand grasps the patient's pronated wrist With the thumb of the right hand behind the lower fragment and the remaining four fingers in front



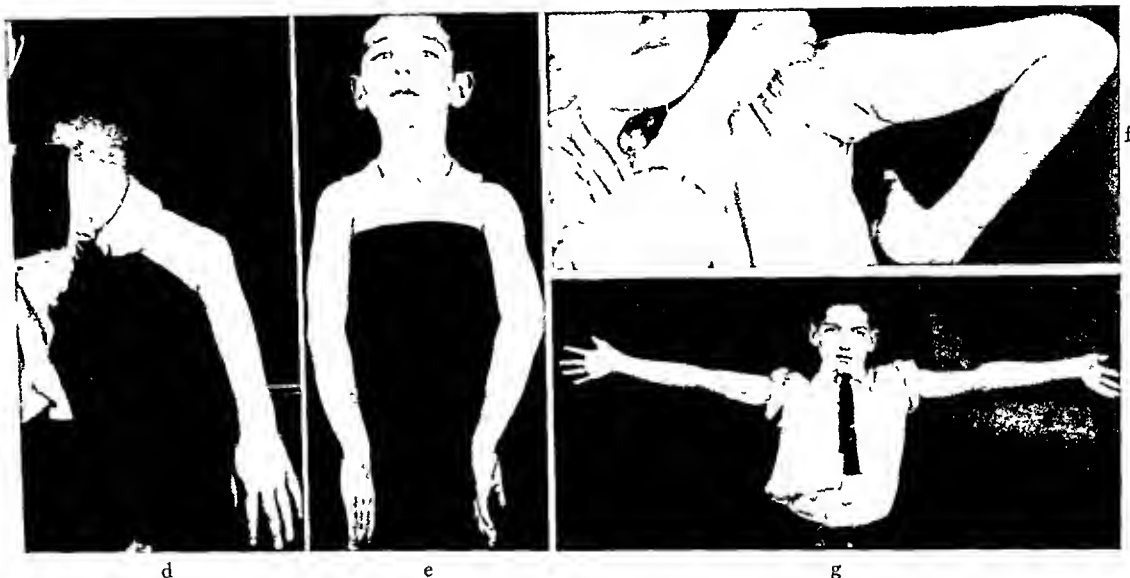
Fig 10 Suspension for unreduced fractures with or without compression of the neurovascular structures



a

b

c



d

e

g

Fig 15 F B, 5 years old a, September 22, 1924, anterior displacement of distal fragment b, October 11, 1924 Persistent forward and upward displacement of the forearm and distal fragment c, December 25, 1932, 8 years later Note contour of lower end of humerus in its

relation to the articular surfaces and the resulting carrying angle d, e, f, g, Photographs made on September 22, 1924, September 19, 1925, and November 12, 1932, when patient was 5, 6, and 13 years old, respectively There is an almost imperceptible varus deformity

#### FIXATION OF FRAGMENTS

Reduction and fixation of the fragments in this series were obtained by the following methods

- 1 Reduction and immobilization in molded splints of plaster of Paris
- 2 Reduction, adhesive plaster dressing, followed by early mobilization
- 3 Suspension for unsuccessfully reduced fractures with or without compression of the neurovascular structures
- 4 Immobilization in a Thomas splint in the treatment of compound fractures
- 5 Skeletal traction by means of a Kirschner wire through the olecranon for "T" or "Y" shaped fractures and in the treatment of compound fractures
- 6 Open operation

Cases

106

178

40

4

1

330

In one case, G R (Fig 6 a, b, c, d, e, f, g, h, i, j) a varus deformity resulted because the mesial displacement of the lower fragment was not corrected

1 *Immobilization in molded splints of plaster of Paris* With reduction completed, the elbow is immobilized in a position of acute flexion with the forearm semi-pronated by means of anterior and posterior molded splints which extend from the shoulder to the base of the first metacarpal. A large crescentic opening should be cut in the plaster so that the radial pulse can be palpated (Fig 7) The elbow must not be flexed beyond a point where resistance is encountered lest the brachial artery be compressed. Diminution or obliteration of the pulse with the elbow flexed

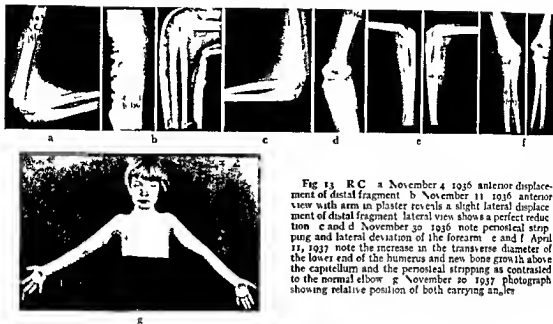


Fig 13 R.C. a November 4 1936 anterior displacement of distal fragment b November 11 1936 anterior view with arm in plaster reveals a slight lateral displacement of distal fragment lateral view shows a perfect reduction c and d November 30 1936 note periosteal stripping and lateral deviation of the forearm e and f April 11 1937 note the increase in the transverse diameter of the lower end of the humerus and new bone growth above the capitulum and the periosteal stripping as contrasted to the normal elbow g November 30 1937 photograph showing relative position of both carrying angles

tory as persistent overriding of the fragments may cause (a) Volkmann's ischemic paralysis, or (b) vicious union. With exuberant callus vicious union impairs function or delays functional recovery. I believe that every surgeon has at one time seen such a case where persistent overriding of the fragments has caused the formation of vicious union which later with the absorption of the exuberant callus has resulted in a complete anatomical and functional recovery (Case 1, V.S. Fig 5 a b, c d e f). Not all such cases will

necessarily result in complete restoration of function. Some may have residual deformity or a limitation in function. To permit the fragments to remain overriding with the thought that the ultimate results may be satisfactory is beset with danger and is not to be recommended.

A correction of the posterior displacement of the lower fragment without a complete reduction of the lateral or mesial displacement may result in a varus or valgus deformity which can be corrected only by means of a cuneiform osteotomy



Fig 14 J.Z. a August 10 1931 after two attempts to replace fragment some persistent angulation persists b October 17 1931 upward displacement of the lower fragment not completely reduced periosteal stripping and a new shaft in process of formation with downward growth of outer aspect of lower end of the humerus c April 10 1937 5 1/2 years later. Some varus deformity present but function is complete

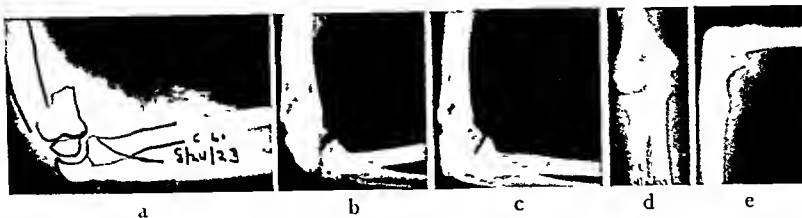


Fig 18 C.L., 7 years old Compound supracondylar fracture, fracture of skull and compound fracture of the femur a, August 24, 1923, anterior and rotary displacement of the lower fragment, osteomyelitis developed treated in suspension b and c, April 15, 1924, and November 1, 1926, note reparative process and changing contour of shaft of the humerus d and e, April 3, 1937, 14 years later, restoration in contour of the shaft of the humerus and complete functional recovery

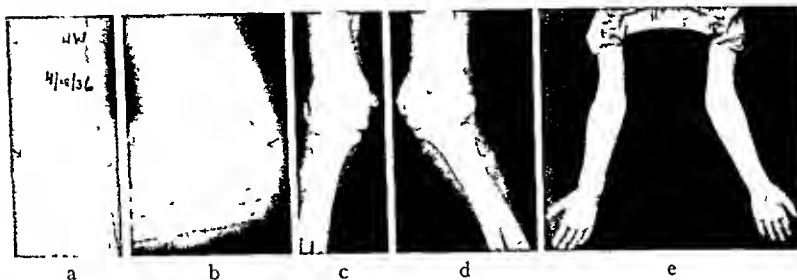


Fig 19 H.W., 9 years old a, April 28, 1936, transcondylar fracture extending above internal epicondyle across the external condyle b, Line through middle of long axis of shaft of humerus passes well behind the posterior border of capitellum instead of about one-third of the capitellum being behind the plane c and d, September 16, 1937, premature ossification of the cartilage plate of the capitellum and external condyle with continued function of trochlea causing an outward deviation of the forearm as contrasted to the normal elbow e, Photograph September 16, 1937, indicating the extent of outward deviation of the axis of the forearm

tion of flexion with the forearm supinated. This method has subsequently been modified by placing the forearm in a position of semipronation (Fig. 8 a, b, c) as it was observed that in the earlier cases the forearm invariably assumed a pronated position irrespective of the efforts made to retain it in a position of supination, and as this pronated position relaxes the flexor-pronator group of muscles the danger is lessened of a recurrence of the displacement which may result in a change of the carrying angle.

The advantage of the adhesive plaster dressing over plaster splints is that the patient can actively exercise the elbow during the entire period of immobilization, and in this manner stimulate the absorption of the extravasated blood and prevent muscular atrophy. The return of function is thus hastened. These active motions can be taken within the confines of the dressing and as the swelling subsides the dressing can be re-applied from time to time so as to increase the range of motion. As in the case of immobilization by splints, forced motion is contra-indicated. At the end of the third week after the dressing has

been finally removed, the range of motion can be further increased. Complete function should be regained in from 6 to 12 weeks following the accident.

It has been observed that in the cases in which the elbow has been completely immobilized for too long a time, as in a plaster splint, the return of function is delayed for a longer period than in the cases in which incomplete mobilization for a similar period by means of adhesive plaster dressing has been used.

Physiotherapy was formerly used but we have discontinued it as it was observed that in those cases in which massage and other means of physiotherapy were used the structures about the elbow became more rigid, thereby increasing the time before function was restored. In some of these cases bony changes occurred in the muscles, a myositis ossificans traumatica (Fig 9). We have recently therefore used only active motion by means of occupational therapy which has given better results.

The objection to adhesive plaster dressing and the reason for reverting to the use of plaster splints lie in the fact that the dressings so fre-

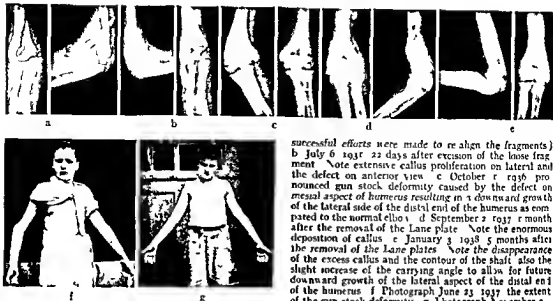


Fig 16 I M 6 years old a June 11 1931 comminuted fracture extending into mesial epiphysis inner fragment rotated anteriorly and displaced forward (Un-

beyond a right angle indicates compression of the neurovascular structures in the antecubital fossa by the distal end of the upper fragment. Failure of the patient actively to flex and extend the fingers is frequently the first intimation of neurovascular impairment. These signs are warnings of the most serious complication in the treatment of fractures about the elbow namely a Volkmann's ischemic paralysis. The recognition that the radial pulse is impaired is an indication that a further attempt at reduction should be made or that the limb be suspended as by either of these

successful efforts were made to re-align the fragments) b July 6 1931 22 days after excision of the loose fragment. Note extensive callus proliferation on lateral and the defect on anterior view. c October 1 1936 pronounced gun stock deformity caused by the defect on mesial aspect of humerus resulting in a downward growth of the lateral side of the distal end of the humerus as compared to the normal elbow. d September 2 1937 1 month after the removal of the Lane plate. Note the enormous deposition of callus. e January 3 1938 5 months after the removal of the Lane plates. Note the disappearance of the excess callus and the contour of the shaft. Also the slight increase of the carrying angle to allow for future downward growth of the lateral aspect of the distal end of the humerus. f Photograph June 23 1937 the extent of the gun stock deformity. g Photograph November 23 1937 5 months after the cuneiform osteotomy. Slight over correction was done to allow for any future downward growth of the lateral aspect of the lower end of the humerus.

methods the pressure upon the neurovascular structures may be relieved.

A roentgenographic examination should be made after the elbow has been immobilized in plaster. It is quite often difficult to visualize the outline of the fragments in the anteroposterior plane with the elbow in flexion when the roentgenograms are taken through four thicknesses of plaster splints (Fig 3 c). Nevertheless repeated roentgenograms should be made until the fragments can be visualized to ascertain the presence of mesial or lateral displacement.

After the splints have been applied, the wrist is suspended with a sling from the patient's neck. At the end of 2 weeks the splints are removed and the forearm can be placed in a sling with the elbow at a right angle. To hasten function the patient is instructed to grasp his wrist with his other hand and with this support actively flex and extend the elbow several times each hour. After another 2 weeks the sling is discarded.

Passive motion is believed to be harmful and should never be practised. Active movements not only exercise the muscles but allow the patient to gauge the amount of movement that is permissible for the movements are gauged by pain.

2. *Adhesive dressing followed by early mobilization.* In 1924 I expressed a preference for the fixation of the injured elbow by means of a non-constricting adhesive plaster dressing in the posi-



Fig 17 F G 7 years old a August 14 1935 19 days after admission after persistent attempts at reduction. Anterior and some mesial displacement of the lower fragment still persist. b May 20 1937. Note the extraordinary reparative process resulting in a satisfactory restoration of the contour of the humerus with an excellent functional recovery.

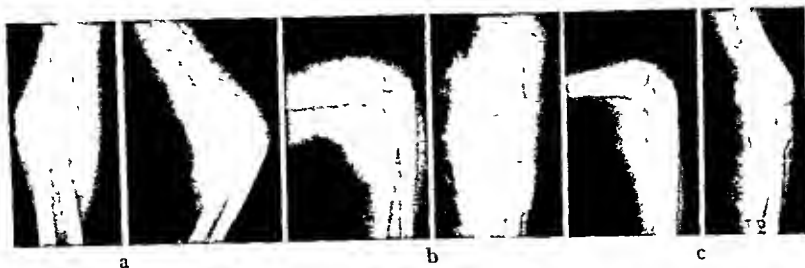


Fig 21 O T, aged 9 years a, August 16, 1936, supracondylar fracture extending into mesial epiphysis with slight posterior and inward displacement of distal fragment b, August 21, 1936, persistent displacement of distal fragment c, December 9, 1936, lateral view shows a subperiosteal deposition of callus, while the anterior view shows the varus deformity because of failure to correct the mesial displacement and probable impairment of the mesial epiphysis d, June 12, 1937, marked gun-stock deformity



Cognizance should be taken of the reparative powers of the child under proper supervision, especially in view of the satisfactory end-results obtained with various types of supracondylar fractures treated by the closed method

#### ANTERIOR DISPLACEMENT OF DISTAL FRAGMENT

The lower fragment was displaced forward in 14 of the 330 supracondylar fractures (4 per cent) Eight of these had no mesial or lateral displacement, in 1 the lower fragment was displaced inward and in 5 rotated outward Two of these fractures extended into the mesial epiphyses In 3 the lower fragment was impacted, being angulated with the upper fragment in a position varying from 30 to 90 degrees This injury, frequently termed the flexion type of supracondylar fracture, resulted from direct violence in all the cases The usual history elicited was that the child fell on the flexed elbow

In 13 cases the fracture was simple and 1 was compound The compound fracture was complicated by a fracture of the skull and a compound fracture of the femur Six of these fractures were transverse and 8 were oblique Three of the transverse and 2 of the oblique fractures were comminuted The varying displacements of the lower fragment, which have been referred to

previously, were accompanied by stripping of the periosteum from the anterior surface of the proximal fragment and off the posterior surface of the lower fragment It is of interest, that there was no impairment of the neurovascular structures in any of these cases either before or after attempts at reduction With the exception of the case of compound fracture, an effort was made in all the others to correct the displacement with the aid of the fluoroscope. In 5 cases a fair or a satisfactory reduction was obtained, in 1 (Case 7, R C) three attempts at reduction were made before a satisfactory alignment was obtained

CASE 7 R C, 7 years old, female, was admitted to the hospital November 4, 1936, with a simple oblique supracondylar fracture in which the distal fragment was displaced completely forward After the third attempt at reduction, the anterior fragment was replaced with only about 10 per cent lateral displacement The elbow was immobilized at right angles in molded plaster splints for 3 weeks By the aid of occupational therapy complete function was regained in approximately 4 months Roentgenographic examination on April 10, 1937, 6 months later, revealed an increase in the transverse diameter of the lower end of the humerus with periosteal stripping and new bone proliferation from the laterally displaced lower fragment This accounted for the increase in the carrying angle of 5 to 10 degrees (Fig 13 a, b, c, d, e, f, g)

Two attempts were made to replace the distal fragment in Case 10, J Z, in which some inward

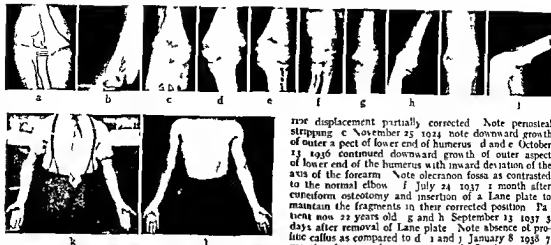


Fig 20. G.D.V. 10 years old. a November 1, 1934 comminuted supracondylar fracture with medial displacement of the distal fragment. b November 23, 1934 post-

operatively applied plaster dressing and cause constriction of the arm, which produces in turn an unnecessary amount of dependent swelling about the elbow and necessitates frequent reapplication.

The adhesive plaster dressing properly applied has caused fewer complications and produced earlier restoration of function than plaster of Paris splints. Unless meticulous attention can be paid to the proper application of adhesive plaster so as to prevent possible constriction it is better that molded plaster splints be used.

3. *Suspension for unreduced fractures with or without compression of the neurovascular structures.* In neglected cases which are seen late it is often necessary to suspend the extremity by means of skin traction applied to the forearm, as the marked displacement and swelling may make reduction of the fracture most difficult or impossible (Fig 10). The surest way of relieving compression of the brachial vessels is to reduce the fragments. However, in a large number of the cases the suspension method has to be followed as it does ease the pressure upon the neurovascular structures even though it is not efficient in reducing the fragments of a supracondylar fracture in which there is displacement. As soon as the swelling has decreased, the suspension can then be discontinued and an attempt can be made to obtain a reduction of the fragments. Continuing the suspension without reducing the fragments results in mal union and the formation of an excessive amount of callus which may cause a persistent deformity and prolonged disability. At times extremely good results are obtained

with displacement partially corrected. Note periosteal stripping. c November 25, 1934 note downward growth of outer aspect of lower end of humerus. d and e October 13, 1936 continued downward growth of outer aspect of lower end of the humerus with inward deviation of the axis of the forearm. Note olecranon fossa as contrasted to the normal elbow. f July 24, 1937 1 month after cubelium osteotomy and insertion of a Lane plate to maintain the fragments in their corrected position. Patient now 22 years old. g and h September 13, 1937 3 days after removal of Lane plate. Note absence of profuse callus as compared to d, 1 and j. January 8, 1938 7 months after cubelium osteotomy. k October 13, 1936 marked gunstock deformity. l November 8, 1937 5 months after cubelium osteotomy. Complete extension and normal axis of the forearm in relation to the elbow.

as the reparative powers of children are such that even with persistent displacements, normal function and anatomical conformation will finally follow (Case 7, R. Q. Fig 11). This return may be delayed beyond the period of time required in cases in which satisfactory reduction has been obtained. It is evident from these statements that there is no justification in failing to attempt to obtain reduction of the fracture as reduction shortens the period of disability and obviates prolonged reparative process.

4. *The Thomas splint* was used in the treatment of four compound supracondylar fractures. It permitted ready access to the wound but otherwise it had no advantage over the overhead pulley adhesive plaster suspension of the forearm at right angles to the elbow.

5. *Skeleton traction.* The suspension of the elbow by means of the Hirschner wire through the base of the olecranon process of the ulna has been advocated by some in cases in which the fragments can not be held in position. This type of suspension may be indicated in cases of persistent posterior displacement with impending neurovascular changes. In the treatment of compound fractures the use of the Hirschner wire should be of great advantage in permitting ready access to the wound for dressing (Fig 12).

6. *Open operation.* Our experience in open operations for the reduction of a supracondylar fracture has been limited to one case and in that it was done for the excision of a loose articular fragment. The roentgenogram must not be the sole factor in determining upon open operation.

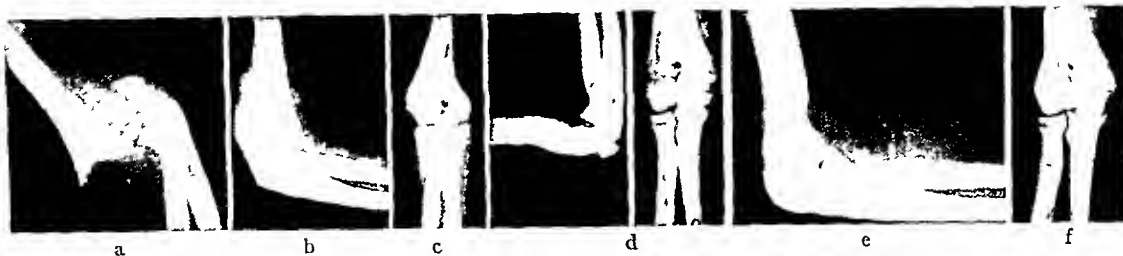


Fig 23 R P 6 years old a, September 1, 1928, complete posterior displacement of the distal fragment and forward rotation of proximal fragment Incomplete reduction and immobilization in plaster accompanied by obliteration of radial pulse and edema of the hand The forearm was suspended and the pulsation was restored b, September 28, 1928, incomplete reduction and persistent rotation forward of the proximal fragment c, November 5, 1928, incomplete reduction of the mesial displacement of the lower fragment with the formation of a new lower end of the shaft of the humerus under the stripped periosteum d and e, November 20, 1933, and May 2, 1936, the extent of the reparative process and the recession of the projecting proximal fragment are shown f, May 2, 1936, anterior view showing reparative process with slight downward growth of the outer aspect



of the lower end of the humerus g and h, October 14, 1936, the range of mobility of the elbow is compared with movement of left arm

mesial epiphysis The distal fragment was displaced completely forward and partially inward Efforts at reduction of the anterior displaced distal fragment was unsuccessful but the mesial displacement was corrected by suspension and the elbow was later immobilized in plaster splints Within a year a new shaft had grown from the distal fragment within the confines of the stripped periosteum from the anterior surface of the proximal fragment The overriding proximal and posteriorly displaced fragment had become absorbed Although the functional recovery was delayed, function was entirely regained at the end of a year without any disturbance in the carrying angle (Fig 17 a and b)

CASE 8 V DeB, male, 8 years old, was admitted to hospital on July 19, 1936, with an oblique comminuted supracondylar fracture with 30 degrees of anterior angulation and some outward displacement of the distal fragment The impaction did not change after an attempt at reduction The elbow was then immobilized in acute flexion with

molded splints for 3 weeks In 3 months the function had been completely regained with a barely perceptible increase in the carrying angle

CASE 14 C L, female, 7 years old, was admitted to hospital July 24, 1923, with a history of having fallen from a roof one-half hour before admission She had evidence of a fractured skull, a compound fracture of the left femur and a compound oblique supracondylar fracture of the right humerus with complete anterior displacement of the distal fragment Partial débridement of all the wounds was done Carrel-Dakin treatment was instituted for the compound fracture of the femur, which was treated by suspension in a Thomas splint from a Balkan frame A sterile dressing was applied to the elbow After an unsuccessful attempt had been made to reduce the supracondylar fracture, the elbow was placed in acute flexion with an adhesive stripping dressing As an infection developed about the elbow the forearm was suspended and the wound was treated with Dakin solution The patient nevertheless

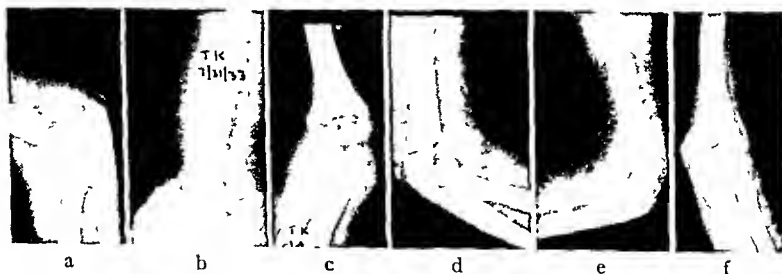


Fig 24 T K a and b, July 31, 1933, forward rotation of the proximal and lateral and posterior displacement of the distal fragment c and d, August 3, 1933, realignment of lateral displacement but some posterior displacement persists e and f, October 28, 1933, note new shaft on lateral roentgenogram and slight lateral displacement of the distal fragment with some periosteal stripping on the lateral border of the humerus One year later the carrying angle showed an increase of 15 per cent





Fig. 22 SS 4 years old Compound supracondylar fracture and a fracture of the lower end of the radius and ulna on September 13 1933 a September 13 1933 posterior and medial displacement of distal fragment and anterior rotation of upper fragment b September 19 1933 persistent posterior displacement of distal fragment immobilized in a posterior molded splint c October 3 1933 after another attempt at correction The posterior displacement persisted note periosteal stripping the forearm was suspended d November 11 1933 note extent of periosteal stripping and the deposition of callus in the

formation of a new shaft e February 27 1934 lateral view showing extent of subperiosteal new bone formation with persistent posterior displacement of distal fragment and the anterior view showing the extensive reparative process f October 10 1935 note the extent of the absorption and recession of the proximal fragment and the contour of the shaft of the humerus g November 20 1937 4 years later The shaft has been restored to normal h November 20 1937 deviation of the axis of the left forearm is practically the same as the right This was taken more than 4 years after accident.

displacement of the lower fragment persisted resulting in a permanent varus This child was followed for 6 years (Fig. 14 a b c)

In 5 children the forward displacement of the distal fragment could not be reduced

CASE 11. I. B. male aged 5 years was admitted to Bellevue Hospital on September 22 1924 1 hour after falling off a bench and striking his left elbow. Marked swelling and distortion were noted about the elbow. Roentgenographic examination revealed complete anterior displacement of the lower articular end of the humerus (Fig. 15 a). Two attempts were made to improve the position of the fragments by means of extension and flexion. Roentgenographic examination on October 11 1924 revealed the capitulum in its normal position in relation to the sigmoid with forward and upward displacement of the forearm capitulum and the rest of the distal fragment resting at right angles to the anterior surface of the proximal fragment (Fig. 15 b). Roentgenographic examination on December 25 1932 at the age of 13 years revealed the trochlea and capitulum epiphyses ossified as well as a normal contour of the articular surface. There is also marked bony growth of the lower and particularly the outer end of the humerus with angulation of the distal end of the humerus (Fig. 15 c). The photographs were taken

September 22 1924 September 19 1925 and November 12 1932 when patient was 5 6 and 13 years old respectively. They reveal the gradual improvement in appearance of the elbow and the excellent range of mobility and almost imperceptible varus deformity (Fig. 15 d e f g).

CASE 4. P. M. male 6 years old was admitted to the hospital on June 6 1931 with a comminuted fracture of the lower end of the humerus which extended into the medial epiphysis. The lower fragment which was fractured from the distal part was approximately 1½ inches long and was rotated anteriorly and displaced above the articular surface. This could not be replaced and on June 14 it was removed. Because of the defect a pronounced inversion of the forearm resulted. The overgrowth of bone upon the lateral condyle and condylar ridge caused a premature ossification of the remainder of the inner humeral epiphysis. The varus deformity was corrected on June 11 1937 by a cuneiform osteotomy and two Lane plates were used to retain the divided bones in their corrected position. The plates were removed on August 2 1937 because of the excessive deposition of callus. With the removal of the plates the callus became absorbed. A satisfactory restoration of the bony contour and function of the elbow has resulted (Fig. 16 a b c d e f g).

CASE 6. F. G. male 7 years old was admitted to the hospital July 26 1936 fell on his left elbow sustaining a simple supracondylar fracture which extended into the

nated wound, (2) the reduction of the fracture especially if there is a protruding proximal fragment with or without stripped muscles, (3) the proper immobilization of the part, and (4) the method of combating the infection. If possible, the condition of the wound being satisfactory, a compound fracture about the elbow should be treated like a simple fracture. This is often possible when there is but a small wound and there is no protrusion of bone. In this type of case the skin can be cleaned, the edges of the wound carefully freed of contaminated tissue, and a dressing applied. The fracture is then reduced and immobilized by means of a posterior molded plaster splint.

A more serious problem arises where the proximal fragment is protruding. The emergency treatment of such cases is of importance as the limb should be splinted in the position in which it is found so that the end of the bone will not be withdrawn and carry contamination into the soft parts. *Under no circumstance should traction be made during the transportation and treatment of a patient with a compound fracture with a protruding fragment.* After the patient is under an anesthetic the first aid splints can be removed. The skin about the wound should be cleansed and the wound washed with saline solution. Scrubbing of the muscles is inadvisable lest one introduce infection into the muscular planes. Especial care must be taken in cleansing the skin edges and the devitalized muscles on the protruding bone. The fracture is reduced and the elbow immobilized. If the wound is not extensive and is comparatively clean, the part may be immobilized by means of a posterior molded plaster splint in the position of acute flexion. If the wound is extensive and there is gross contamination, it seems preferable to suspend the forearm in a position of acute flexion from an overhead pulley extension frame and treat the wound immediately by the Carrel Dakin method. The same method of suspension and irrigation with Dakin's solution should be used if infection supervenes in patients treated by immediate splinting. In all of these, free drainage must be established. The primary consideration is to preserve the limb and prevent a general sepsis. Although some effort should be made to maintain the fragments in the corrected position, this consideration should be secondary. If no infection supervenes the suspension may be discontinued in a week's time when the elbow can be immobilized by means of molded splints.

#### CAUSES AND TREATMENT OF DELAYED FUNCTION

A significant relationship exists between the unreduced or partially reduced supracondylar

fracture and delay in restoration of function. This protraction of the period of disability may be due to some complication of the fracture or may be the result of treatment.

1. *Malunion a. Persistent overriding of the fragments.* In such cases there is delay in functional recovery until callus has been deposited beneath the stripped periosteum and the protruding distal part of the upper fragment has been absorbed. Because of this, attempts at closed reduction should be continued to better the position of the fragments up to as late as 2 weeks. If these attempts are unsuccessful, the soft callus can be gently dismembered so that traction can be used. Skeletal traction, by means of a Kirschner wire to be inserted 1 inch below the olecranon process, is recommended. The elbow can then be suspended by means of this traction in a position of flexion with forearm pronated. Open operation at this late date may cause the deposit of a prolific amount of callus which may result in an elbow with limited function.

Excellent functional elbows have followed in cases in which overriding remained. In these cases, massage or forcible efforts are absolutely contra-indicated, but the patient can be encouraged to use the elbow freely. The limitation in motion is overcome gradually as the excessive callus is absorbed together with the recession of the distal end of the proximal fragment.

b. *Mesial displacement of the rotated lower fragment,* in such cases malunion and overgrowth of the lateral condyles result. This causes a deviation of the mesial aspect of the elbow with varus deformity. Every attempt should be made to correct the rotation and mesial slide of the distal fragment before union is completed and the elbow should always be immobilized in a position of flexion with the forearm semipronated. If a pronounced varus deformity has been established, it can, when the child has reached full growth, be corrected by means of a cuneiform osteotomy (Case 3, R. P., Fig 23, a, b, c, d, e, f, g, h).

c. *Lateral displacement of the rotated lower fragment.* This causes an overgrowth of the mesial aspect of the elbow and an outward deviation of the forearm. This deformity is less obvious than the varus and not as apt to affect function. It should be prevented, however, by means of proper reduction and immobilization. Fig 24.

d. *Varus or valgus deformity.* This is caused by a fracture of the diaphysis which extends through one of the epiphyseal plates and causes premature ossification and a unilaterally arrested growth of the affected side with normal growth of the opposite side. (For details see epiphyseal injuries.)



Fig. 23. An effective form of occupational therapy

developed an osteomyelitis of the fractured humerus and femur. The wounds gradually healed and the patient was finally referred to occupational therapy. For months the elbow was very resistant to treatment but gradually function returned until it was finally complete. Some atrophy of the interosous muscles of the hand developed but there was no impairment of sensation of the skin supplied by the ulnar nerve. With massage and high frequency current the condition of the hand improved after about 3 years. When seen in April 1937 14 years after injury the patient had complete function of the elbow with no evidence of ulnar nerve impairment. The previous ulnar nerve disturbance was attributed to the pressure of a prolific amount of callus. With the absorption of the callus and the restoration of the normal contour of the humerus the signs and symptoms of ulnar injury disappeared (Fig. 18 a b c d e).

In evaluating the method of treatment in these 14 cases of forward displacement of the distal fragment it appears that the results were equally satisfactory whether complete reduction was obtained or not. There was no limitation of function in any of the 13 cases that were followed in 1. Case 12, D G, the child, against advice, left the hospital after the fracture had been reduced

and could not be traced. Three of the children, in whom the fractures were not reduced, and 5 in whom a satisfactory reduction was attained, ultimately had normal carrying angles. In 3 cases there was a varus deformity in 2 of these two unsuccessful attempts had been made at reduction. In 1 case there was a slight valgus and in another there was an increase in carrying angle due to 10 per cent displacement of the lower fragment; this child had three attempts at reduction.

Analysis of these cases would lead one to infer that a proper supervision of the patient without attempts at reduction was as satisfactory as subjecting the patient to manipulation. This conclusion, however, I believe is not justified as the function is restored earlier if the fracture is properly reduced. The principle of allowing the distal fragment to remain displaced and heal by vicious union is basically unsound, and I believe that in all cases, an attempt should be made to obtain a satisfactory reduction, and in none should the fragments be allowed to remain out of alignment unless several unsuccessful attempts at closed reduction have been made.

#### EPIPHYSEAL INJURY

A separation of the lower epiphyses of the humerus as a whole which would include the centers of ossification of both the capitellum and trochlea has been referred to by some writers as a distinct entity. Our experience does not substantiate such a view. Wilson (9) has never encountered a 'true epiphyseal displacement of the lower end of the humerus. A study of our roentgenograms also failed to disclose such an injury. A separation through the epiphyseal line may be apparent at first in the roentgenogram but on further study it has been found that invariably the fracture line extends across the diaphysis



Fig. 26. A C, 5 years old. a August 17 1932 posterior displacement of the distal fragment and anterior rotation of the proximal. b September 12 1932 28 days later showing persistent forward rotation of the proximal fragment. c The posterior displacement corrected approximately 80 per cent. The forearm was suspended on the twenty eighth day. d November 12 1932 note new shaft under the stripped periosteum. e The medial displacement of the distal fragment was corrected by suspension.

at reduction was made 2 days later, which improved the position of the fragments. There was no evidence of circulatory disturbance when the boy was discharged to the Out Patient Department at the end of 15 days. On the twenty-eighth day he was readmitted to the hospital with a limitation of extension and flexion of his fingers. The roentgenogram disclosed that the upper fragment was displaced forward and inward. The limb was therefore suspended by the forearm with the elbow flexed at a right angle. Two weeks later there was slight improvement in the mobility of the hand. However, there was definite evidence of a Volkmann's paralysis. The patient was subsequently treated by means of traction of the fingers in a banjo splint, and later with plaster splints, his wrist in flexion and his fingers in extension, this was followed by gradual extension of the wrist. Function of the elbow was slow in returning, but finally at the end of 4 years full function was obtained. However, full extension at the wrist joint remained impaired (Figure 26, a h c d e).

This case is cited to call attention to an unusually late form of ischemic paralysis. It is more than probable that the circulatory changes due to the displacement of the fragments had begun before the patient's discharge from the hospital. The onset was slow and insidious but progressive, and consequently the onset of the paralysis was overlooked until it had fully developed.

It is believed that suspension of the limb prevented the onset of an ischemia in 7 of the cases though the fragments were not completely reduced and vicious union resulted in prolonged disabilities. Proper reduction and immobilization should have precluded these sequelæ.

The treatment of Volkmann's ischemic paralysis requires particular care and patience on the part of the attendant, because it is difficult to overcome the contracture and to prevent and treat trophic ulcers.

#### CONCLUSIONS

An analysis has been made of 330 cases of supracondylar fracture treated on the Children's Surgical Service of Bellevue Hospital during the past 18 years.

In 72 cases (22 per cent) there was no displacement of the fragments. The distal fragment was displaced posteriorly in 244 cases (74 per cent). Fourteen cases (4 per cent) are reported with a forward displacement of the lower fragment. Of the 330 fractures, in 21 (6 per cent) the line of fracture extended into the epiphyseal cartilage plate.

Of the 292 cases which were followed, 168 (58 per cent) can be said to have excellent results, 30 (10 per cent) good, 69 (24 per cent) fair, 15 (5 per cent) poor, and 10 (3 per cent) bad. These results include 52 cases (18 per cent) which are still under treatment. Many may improve in their function and will deserve a better classification.

The cause of delay in return of function was due first to a failure to obtain a satisfactory reduction of the fracture; second, to Volkmann's ischemic paralysis; third, vicious union; fourth, muscle spasm, fifth, myositis ossificans, and sixth, pressure on the ulnar or deep muscular branch of the radial nerve until the excessive callus was absorbed.

Thirteen of the 14 cases of anterior displacement of the distal fragment obtained satisfactory end-results without operative interference.

Of the 12 compound fractures, complete function was obtained in 10 cases, partial in 1, and an ankylosis in 1. Attention is directed to the danger of using traction as a first aid method in cases in which the proximal fragment protrudes through the skin lest it recedes and contaminates the deeper part of the wound.

The sooner efforts are made to reduce the displacement the more readily can the fragments be replaced and in consequence the shorter the period of disability.

To retain the reduction of the fragments so as to prevent a cubitus deformity, the part must be immobilized with the elbow flexed and the forearm semi-pronated.

It has been found that reduction can be effected even in the presence of a soft callus as late as two weeks after injury.

Failure to reduce a posterior or anterior displacement of the distal fragment in the absence of mesial or lateral displacement may result in a normal restoration of the contour of the humerus without deviation of the axis of the forearm and a complete functional recovery.

Failure to reduce the mesial or lateral displacement or rotation of the distal fragment will result in a varus or valgus deformity which the reparative powers of the child cannot change and which can be corrected only by means of a cuneiform osteotomy.

Failure to replace the lower fragment prolongs unnecessarily the period required for the return of function, because of the time it takes for the formation of a new shaft within the stripped periosteal tube.

The anteriorly displaced upper fragment pressing upon the neurovascular structures in the tense antecubital fossa is the dominant factor in the production of Volkmann's ischemic paralysis. Suspension of the forearm averted the development of this complication in 8 cases.

The line of fracture may extend through the epiphyseal cartilage plate of one of the epiphyses and cause a premature ossification in that epiphysis, resulting in a unilateral arrest of growth,

2 *Muscle spasm delays functional recovery* Although this complication occurs most frequently in fractures that have not been completely reduced it may also occur after satisfactory reduction if forceful efforts or kneading massage is used (in attempts to increase the range of mobility of the elbow). In this respect too strenuous condemnation of manipulative procedures cannot be urged, whether with or without an anesthesia. Through these procedures the injured muscles are further traumatized and though the range of mobility may be increased at first, this manipulative procedure is always followed by a greater limitation of motion and more apprehension on the part of the child. I believe that muscle spasm should never be treated by any form of physiotherapy, but that the patient should be encouraged in the use of the elbow by treating him with some form of occupational therapy (Fig 25).

3 *Myositis ossificans traumatica* This complication has not been encountered on the Children's Surgical Service since the first group of cases were reported. It is believed that myositis ossificans traumatica results from repeated trauma to already injured muscles and periosteum. We believe, therefore, that the presence of the 7 cases of this complication, in the former group, was the result of massage and passive motion, which we then used, for when the presence of myositis ossificans was recognized and the physiotherapy had been discontinued, all evidence of this complication disappeared within a few months. Dean Lewis believes that "periosteal stripping plays an important rôle in the development of periosteal callus and ossifying myositis." But in this series we have not observed this complication unless there was added trauma, which had been caused by some form of physiotherapy.

4 *Volkman's ischemic paralysis* The posteriorly displaced lower fragment carrying the forearm with it causes the neurovascular structures, which are intimately bound to the latter, to impinge upon the distal sharp end of the anteriorly displaced proximal fragment. Nine cases of impending Volkman's paralysis were recognized in this series because of absence or impairment of the radial pulse. By recognizing this premonitory sign, further damage was averted, either by means of obtaining a satisfactory reduction of the fracture and immobilization of the part or through suspension of the forearm. Both of these methods relieve the pressure on the neurovascular structures by the proximal fragment.

Ischemic paralysis has been reported by some to be due to pressure of a hematoma within the

antecubital fossa even though there be no displacement of the fragments. Others have ascribed it to constrictive dressings. Neither of these causes have been encountered in this series.

Numbness, cyanosis, swelling, inability to extend the fingers without causing pain, and impairment of sensation indicates that the disease has progressed. These symptoms are actual signs of ischemic paralysis and therefore should not be awaited before measures of relief are instituted. The slightest impairment of the pulsation of the radial artery is the warning that danger is impending.

The cases in which this complication was threatened followed unsuccessful attempts at reduction in which the arm was immobilized in acute flexion. In 8 instances the radial pulse became imperceptible and the fingers began to swell, thereupon the dressings were removed. In 6 of these the forearms were suspended and in 2 the displacement was corrected by further manipulation after which the elbow was immobilized in flexion by means of plaster splints. In all of these 8 cases the pulsation of the radial artery immediately returned. In each the roentgenogram showed a forward displacement of the proximal fragment. The suspension of the limb in 6 cases did not improve the position of the fragments but did immediately relieve the pressure upon the neurovascular structures. With the exception of 1 case (Case 6), 5 were treated by suspension until union was firm. In this case a reduction to the extent of 80 per cent was obtained through manipulation as late as the eighth day and the elbow was then immobilized in flexion by means of plaster splints. In all 8 cases complete function was regained and none showed further signs of ischemia. One child now has a normal carrying angle, 1 a valgus and 6 varus deformities varying from 5 to 10 degrees. The change in the carrying angle resulted from a failure to correct the mesial or lateral displacement of the distal fragment.

Case 5 (A C) is of sufficient interest to report in detail as the circulatory disturbance was of an insidious nature, inasmuch as the condition was not recognized until 2 months following discharge from the hospital.

CASE 5. A C. 6 years old fell on his outstretched hand on August 16, 1932. There was the typical clinical picture and roentgenographic findings of a supracondylar fracture with a complete posterior and lateral displacement of the distal fragment. An attempt was made to reduce the fracture following which the elbow was immobilized in acute flexion. At this time there was no evidence of impairment of circulation. The x-ray film however revealed an unsatisfactory position of the fragments. Another attempt

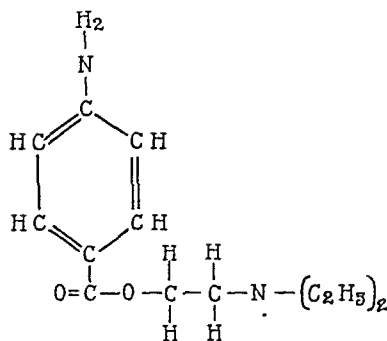


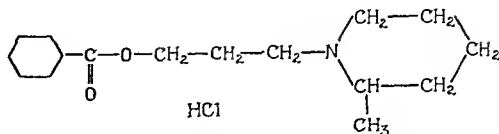
Fig 1 Procaine

not a few cases, when metycaine was used, anesthesia was complete when the injection was completed. The regularity with which anesthesia was rapidly established in 667 cases emphasized the advantage which metycaine has as a local anesthetic agent for sacral plexus block. There is a definite time-saving factor for the surgeon when metycaine is used because anesthesia is established quickly, and a benefit to the patient because prolonged anesthesia makes the postoperative period more comfortable.

#### PREPARATION OF THE SOLUTION

One 5 cubic centimeter ampul of 20 per cent solution of metycaine is added to 95 cubic centimeters of physiologic solution of sodium chloride, the temperature of which is maintained at about 37.5 degrees C. The contents of another ampul containing 1 cubic centimeter of 1.2600 solution of epinephrine is added to the solution of metycaine and sodium chloride. Under certain circumstances, such as marked hypertension or thyrotoxicosis, or in the presence of some cardiac condition such as angina pectoris, the epinephrine is omitted.

Briefly, 25 to 30 cubic centimeters of 1 per cent metycaine is injected into the caudal canal, and 15 cubic centimeters of the same solution is injected transsacally on each side, in the second, third, and fourth foramina, 10, 3, and 2 cubic centimeters, respectively, being used. The total



HCl

Hydrochloride of gamma-(2-methyl piperidino)-propyl benzoate

Fig 2 Metycaine

amount of 1 per cent solution of metycaine used is usually 60 cubic centimeters.

#### SUMMARY

Metycaine may be substituted for procaine as a local anesthetic agent with certain advantages. It produces anesthesia in equivalent dosages more rapidly than does procaine and anesthesia is more enduring than when procaine is used. Clinically it is no more toxic than procaine as a regional anesthetic. Metycaine, which is a fourth as toxic as cocaine, may be used instead of cocaine for topical anesthesia with satisfactory results. It may be of interest to some anesthetists who are sensitive to contact with procaine that they may try metycaine as an alternative local anesthetic agent. I know of a physician who had dermatitis from procaine but who is able to use metycaine with impunity.

#### REFERENCES

- 1 LUNDY, J. S. A method for producing block anesthesia of the sacral nerves. *Am J Surg*, 1928, 4: 262-270.
- 2 McELVAIN, S. M. Piperidine derivatives. IV. Substituted piperidine-alkyl benzoates and para-aminobenzoates. *J Am Chem Soc*, 1927, 49: 2835-2840.
- 3 MEEKER, W. R., and McCRLARY, P. L. Metycaine in spinal anesthesia. *Am J Surg*, 1934, 24: 139-141.
- 4 ROMBERGER, F. T. Comparative scope and clinical utility of various agents and techniques in spinal anesthesia. *Current Res Anes & Anal*, 1933, 12: 152-155.
- 5 ROSE, C. L., COLES, H. W., and THOMPSON, HELFN E. Studies in the pharmacology of local anesthetics. III. Comparison of gamma-(2-methyl piperidino)-propyl benzoate hydrochloride with cocaine and procaine on experimental animals. *J Lab & Clin Med*, 1930, 15: 731-735.
- 6 TUOHY, E. B. The use of metycaine in spinal anesthesia. *Surgery*, 1937, 2: 39-45.

which is followed by a deformity due to the normal growth of the unaffected epiphysis.

Open reduction does not appear to be justified in supracondylar fractures in view of the uniformly good results obtained by various procedures for closed reduction.

The author wishes to express his appreciation to Dr Fenwick Beckman, surgeon in charge of the Children's Surgical Service, for permission to report on these cases and for his many helpful suggestions.

## REFERENCES

1. POPPLER LORENZ: The Treatment of Fractures. Baltimore: William Wood & Co., 1931. 190-191.

2. CONY I: Observations based on a study of injuries to the elbow. Arch Surg. September 1921. 3. 35.
3. Idem: Observations on the normally developing elbow. Arch Surg. 1921. 2. 455-492.
4. JONES KENNET: Injuries to joints. London: Henry Rowland Oxford University. 1914. 8.
5. LEWIS DEAN: Mayo Clinic Reports. J. Am. M. Ass. 1923. 80. 1281.
6. LUSK W. C.: Reduction of supracondylar fracture of humerus. Ann Surg. 1908. 37. 433.
7. POLAND J.: Traumatic Separation of the Epiphysis. Landon Smith Elder & Co., 1898.
8. STOUT, LEWIS E.: Elbow fractures and dislocations. Surg. Gynec. & Obst., 1925. 40. 665.
9. WILSON P. D.: Fracture of the lateral condyle of the humerus. J. Bone & Joint Surg. 1936. 18. 306.
10. Idem: Fracture of the lateral condyle of the humerus. J. Bone & Joint Surg. 1936. 18. 316.

# THE USE OF METYCAINE FOR PRODUCING BLOCK ANESTHESIA OF THE SACRAL NERVES

EDWARD B. TUOHY, M.D., M.S. (Anes.), Rochester, Minnesota

THE technique and indications for producing anesthesia of the sacral nerves have been described elsewhere (1). It is not the purpose of this paper to offer any changes in fundamental procedure but to suggest that a new anesthetic agent, metycaine (2) may be used to advantage instead of procaine.

Chemically, procaine and metycaine (2) are related in that they are both derivatives of cocaine, but the addition of substitution products causes the two agents to have different chemical and clinical properties (Figs. 1 and 2). Metycaine is both a local and a topical anesthetic agent, whereas procaine does not possess any local anesthetic action on topical application. Metycaine also possesses antiseptic properties which are not present in procaine.

Mecke and McCreary, who have compared the anesthetic potency of procaine and metycaine by means of intradermal injection, found that anesthesia which was induced with 0.0625 per cent of procaine without epinephrine, lasted 5 minutes, whereas anesthesia which was induced with an equal amount of 0.0625 per cent of metycaine lasted 14 minutes. Several other workers (4, 5) have confirmed these observations that anesthesia which is induced with metycaine is more enduring than that which is induced with procaine. The toxicity of these agents has been studied by means

of injecting them intravenously into animals. When metycaine is injected intravenously, it is found to be two or three times more toxic than procaine but, clinically, Ross and others have found that metycaine is no more toxic than procaine. Further, in comparison with cocaine, metycaine is about a fourth as toxic as cocaine and possesses considerable anesthetic power. A 2 to 4 per cent solution of metycaine is the usual strength for topical anesthesia. I have used metycaine for infiltration and block anesthesia with satisfactory results and have not noticed any evidence that metycaine was more toxic than procaine.

As an agent to produce anesthesia of an individual nerve or of several nerves such as those of the brachial or sacral plexus, metycaine has been found to produce quicker anesthesia in equivalent doses and the anesthesia lasts about 50 per cent longer than that produced with procaine. Previously 1 per cent procaine with epinephrine was the agent usually used for caudal transsacral anesthesia. With this agent and concentration, it was expected that anesthesia would be established within 12 to 15 minutes after completion of the injection and that the duration would vary from 1 to 2 hours. When 1 per cent metycaine with epinephrine is used, anesthesia usually is complete within 6 to 8 minutes after the injection has been completed and endures for 2 hours or longer. In

When the baby leaves the uterus, the uterus contracts and is so reduced in size that the placenta cannot possibly remain attached; it is therefore cast off from the uterine wall. It is wrong to suppose that only a part of the placenta begins to separate and that it separates gradually. The entire placenta separates immediately, as soon as the baby leaves the uterine cavity.

The only exception to the immediate separation of the placenta is in the pathologically adherent placenta accreta, which fortunately occurs so rarely. In these 11,000 cases there were no cases of placenta accreta. The usual so called adherent placentas are in reality only retained placentas. The uterus in those cases is so firmly contracted down on the placenta that it gives the impression that the placenta is adherent, but in reality it is only retained. The parts of the secundis that do remain attached to the uterus are parts of the membranes around the periphery of the placenta. There is no special mechanism by which the membranes become detached from the uterus, they are dragged away from the uterus when the placenta is delivered.

The management of the third stage is as follows: When the baby is delivered the nurse follows down the uterus through the abdominal wall and holds it firmly. The baby is cared for by tying the cord, placing an identification tag on it, and treating the eyes, all of which takes about 3 minutes. If there is a probability of the rubber gloves having been contaminated during the delivery they are changed. An artery clamp is placed on the cord close to the vulva. A vaginal examination is made with two fingers of the right hand, while the left hand holds the artery clamp that is on the cord. The nurse makes pressure on the uterus forcing the placenta down and out of the uterus, aided by a little traction on the cord by the left hand. The placenta is then guided out or lifted out of the vagina by the right hand (Fig 1). The membranes are dragged out after the placenta, to prevent tearing, artery clamps are used to grasp the membranes as they appear at the vulva. One ampul of pituitrin is injected and an ergot preparation is given either by mouth or intramuscularly.

The placenta is nearly always delivered by this procedure in about 3 minutes after the delivery of the baby. If progress is not made it may be that pressure is not exerted in the right direction. The pressure on the uterus should be so placed that the force will be exerted over the placenta and directed toward the outlet. The vaginal fingers determine whether the pressure on the uterus is in the right direction, the procedure is

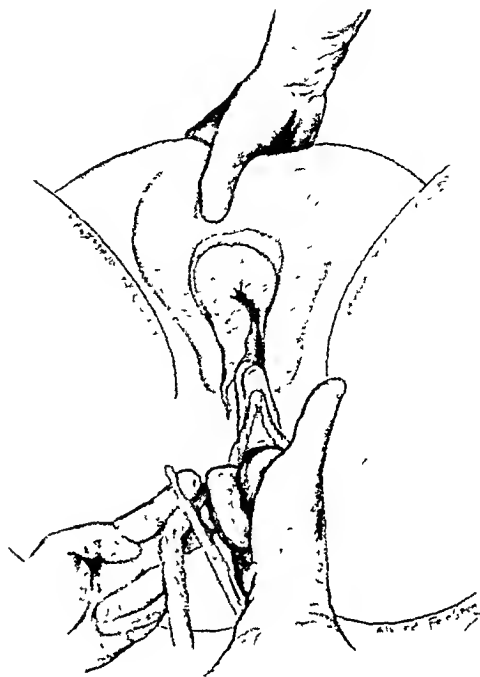


Fig 1 The delivery of the placenta. Vaginal examination is made with two fingers of the right hand, to determine whether the placenta is ready for delivery. The left hand makes a little traction on the cord, while the nurse pushes down on the uterus from above and the placenta is expelled from the uterus. It is lifted out of the vagina by the right hand.

then continued until the delivery of the placenta is accomplished.

A bimanual examination is then made to assure that the uterus is well contracted and to detect lacerations. The placenta is examined by inspecting both surfaces, the membranes and the blood vessels. No elaborate methods are necessary to verify that parts are not missing.

When the fingers of the right hand enter the vagina and cervix, the placenta is encountered either in the Duncan or the Schultz position or in different variations of these presentations. The placenta is found to be separated, lying loose in the uterus, and partly protruding from the cervix into the vagina. Often the membranes at the rim of the placenta will be found attached to the uterine wall. These attached membranes frequently hold back the placenta from being expelled. The examining fingers in that case reach up in the lower uterine segment and detach the membranes from the uterine wall, permitting the placenta to come down. This does not mean that



# MANAGEMENT OF THE THIRD AND FOURTH STAGES OF LABOR

Based on Eleven Thousand Deliveries

MORRIS LEFF, M.D., New York, New York

**C**ONSIDERABLE uncertainty and disagreement as to the proper management of the third stage of labor still persists. Ever since recorded time, numerous methods have been advocated and used with variable success or failure. All agree that the third stage requires proper management but differ as to what constitutes the correct method.

The observations to be presented here are based on 11,000 cases delivered at our hospital of these 7,500 were my own private cases delivered by me, and 3,500 cases were delivered by other doctors, and directly or indirectly supervised by me.

The third stage of labor embraces the period from the birth of the child to the delivery of the placenta. After the delivery of the placenta the puerperium is assumed to begin. However after the delivery of the placenta there is a very important and dangerous interval that lasts from a few minutes to several hours which requires the serious attention of the obstetrician. That interval between the delivery of the placenta and the time that the patient is safely in bed without any more danger of hemorrhage should be designated as the fourth stage. After this stage, then the puerperium can be considered to begin.

The third stage of labor consists of two phases: the first, the separation of the placenta and the second, the delivery of the placenta. The separation of the placenta is a normal physiological process which is accomplished entirely by the contraction of the uterus and the reduction in its size as soon as the baby is born while the second phase, the delivery of the placenta, is as a rule not accomplished by the natural forces but must have the assistance of the obstetrician.

In primitive people, if the woman delivered in the erect posture the cord and the placenta would be dragged out with the baby or could come out by the force of gravity. In civilized times with the woman delivering in the supine position the natural forces cause the complete separation of the placenta, but as a rule these forces do not

complete the process of expulsion of the placenta. The delivery of the placenta has to be aided artificially. It is only occasionally that powerful uterine contractions force the placenta out of the vagina. We must recognize as a fundamental fact, that in humans, nature does not provide for the expulsion of the placenta spontaneously and that it is therefore necessary for the obstetrician to aid in its delivery, just as definitely as it is necessary to tie and cut the umbilical cord. Since the obstetrician must aid in the delivery of the placenta it is essential to know exactly the mechanism of the third stage. The mechanism can be ascertained in each case only by vaginal examination, as indicated in my paper, 'Vaginal Examination in the Third Stage of Labor as a Guide to Its Management' (December, 1929).

The generally considered signs of separation of the placenta are of no value. Placing a clamp on the cord at the vagina and watching its descent does not indicate that the placenta is separating, because by the time the clamp is placed on the cord the placenta is already separated. Pushing up on the uterus through the abdomen and noticing that the cord rises up with it, is no indication that the placenta has not separated because the placenta will accompany the uterus although it is separated and is simply held by the lower uterine segment and cervix. The globular or flattened shape of the uterus is no indication that the placenta has or has not separated. There are no external signs by which we can know that the placenta has separated and is ready for delivery. Vaginal examination therefore must be done. I consider it indispensable in the management of the third stage of labor.

Vaginal examination is done by me in all stages of labor. Introducing the sterile gloved hand in the vagina does not cause infection. It gives definite and positive information as to the conditions present and eliminates guesswork and mistakes. I am convinced that vaginal examination under aseptic precautions does not produce infection. In the 11,000 deliveries we have not had a single case of puerperal sepsis and the morbidity in general was exceedingly low.

When the baby leaves the uterus, the uterus contracts and is so reduced in size that the placenta cannot possibly remain attached, it is therefore cast off from the uterine wall. It is wrong to suppose that only a part of the placenta begins to separate and that it separates gradually. The entire placenta separates immediately, as soon as the baby leaves the uterine cavity.

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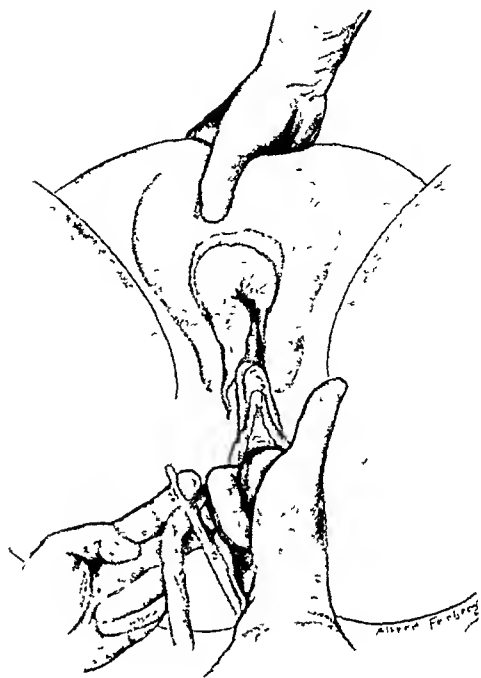


Fig. 1 The delivery of the placenta. Vaginal examination is made with two fingers of the right hand, to determine whether the placenta is ready for delivery. The left hand makes a little traction on the cord, while the nurse pushes down on the uterus from above and the placenta is expelled from the uterus. It is lifted out of the vagina by the right hand.

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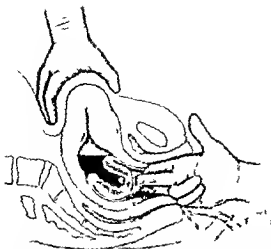


Fig. 2 The placenta presenting in the Schultze manner. The examining finger pokes a hole in the presenting part of the placenta permitting the accumulated blood to drain out and the placenta to collapse and to be more easily expressed.

the placenta is not separated—only that the membranes at the rim of the placenta remain adherent. They would remain attached no matter how long one would wait as there is no mechanism for the membranes becoming detached except by being dragged away when the placenta is delivered.

When the fingers encounter the placenta presenting in the Schultze manner there is usually no visible bleeding as the placenta obstructs the entire cervical outlet but invariably there is bleeding in back of the placenta. This blood forms the so called retroplacental hematoma which is the result of the placenta staying in the uterus and which keeps the uterus distended and increases the bleeding. Before an attempt is made to express the placenta in that case the accumulated blood should be permitted to drain out. This is done by poking a hole in the presenting part of the placenta with the examining finger permitting the blood to run out and uterus to contract (Fig. 2). The placenta then folds up on itself and permits the uterus to contract further and the placenta is then easily expelled. This procedure also avoids the splash of blood which otherwise accompanies the delivery of the placenta. To press on a uterus which is distended while the cervix is dilated as it is when the placenta presents by the Schultze method is to invite the danger of inversion of the uterus. By the above maneuver this is prevented. We have not had any cases of inversion of the uterus in the entire series.

Occasionally, as the baby is delivered the cervix closes down immediately. On vaginal examination the cervix will be found to be entirely closed or only one or two fingers dilated under these circumstances the placenta cannot be delivered although it is separated. When there is no dilatation nothing can be done but to wait for the uterus to relax and for the cervix to open up. These are the cases in which the placenta may be retained and may require anesthesia and manual removal. If a piece of placenta protrudes into the cervical canal it will act as a wedge and dilate the cervix. When the cervix is about two fingers dilated then the examining fingers are held in the cervix and aid in the dilatation of the cervix they are kept there until the cervix is sufficiently dilated for the placenta to be expressed. When the cervix is closed or partially closed pressure is not made on the uterus, but it is rather allowed to relax for with the relaxation of the uterus the cervix also relaxes and dilates. When the cervix is sufficiently dilated then pressure is made on the uterus and the placenta is expressed. It is the occasional closing down of the cervix which prevents us from delivering every placenta immediately. But when the cervix is open all placentas are and should be delivered promptly without delay.

If the placenta is retained in the uterus only one hour is allowed to elapse before manual removal is done. There is nothing gained by waiting any longer. The anesthesia relaxes the uterus and cervix and the placenta can then be removed. The membranes at the margin of the placenta may be found adherent but the placenta itself is separated. It is not advisable to wait a longer time for the removal of the placenta as persistent bleeding is bound to occur which may be slow and small in quantity but in time adds up to a considerable amount. This blood loss is unnecessary and may become dangerous. The mental strain on the patient and the doctor in waiting must also be considered. Furthermore we know that in about 3 hours the uterine cavity becomes invaded with micro-organisms and if we delay the removal of the placenta it would involve manipulation in an infected area instead of in a comparatively clean uterus. By delivering the placenta promptly as has been indicated the cervix does not get a chance to close down on the placenta so that fewer cases of retained placenta occur which require manual removal.

The Mojon Gabaston method of inducing the separation of the placenta has recently been resurrected. It is mentioned here only to be condemned. Fortunately in the cases described in

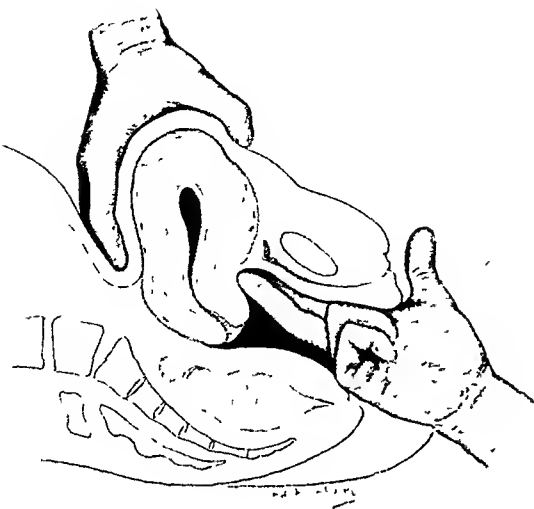


Fig 3 Fourth stage of labor Bimanual compression of the uterus to control hemorrhage Two fingers of the right hand are inserted in the anterior fornix, they push the uterus up against the abdominal hand, thus causing compression of the uterus

which the method was used, the placentas undoubtedly had already been separated Had it really been used in adherent placentas the fluid injected would have penetrated the uterine wall and caused tearing of the uterus

When the baby is delivered and there is a gush of blood and the bleeding continues, immediate attention should be given to the placenta The cord is promptly clamped and cut and the baby is handed to the nurse The placenta is immediately delivered and the bleeding controlled Any and all bleeding before the placenta is delivered is to be considered unnecessary, and is an indication that the placenta should be delivered without the least delay

The natural process by which bleeding from the uterus is controlled is by the retraction and contraction of the uterus Anything which helps contraction of the uterus will help control the bleeding, and anything which interferes with the contraction of the uterus will increase the bleeding Therefore a uterus which is exhausted from a prolonged first and second stage is more apt to bleed Anesthesia definitely interferes with the contraction of the uterus, consequently the deeper the anesthesia the longer will the uterus remain relaxed and induce bleeding It is therefore advisable to use as little anesthesia as possible, and to discontinue it promptly as soon as the baby is delivered For the same reason a mini-

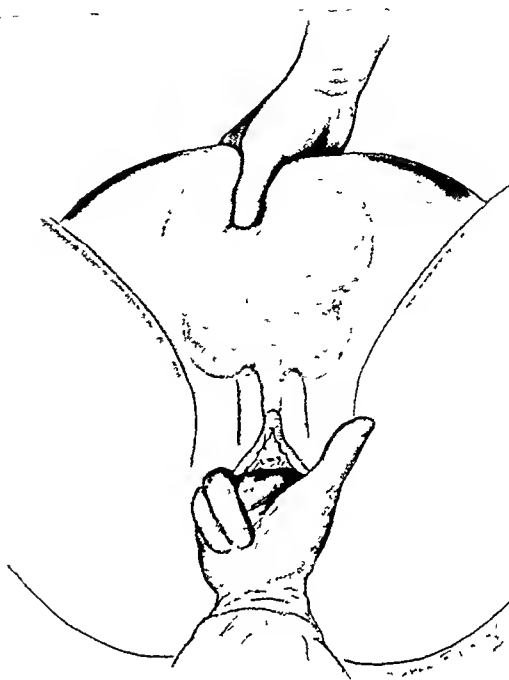


Fig 4 Fourth stage of labor Bimanual compression of the uterus with closure of the cervix Two fingers of the right hand are inserted into the lateral fornices They compress the cervix, closing it, and at the same time they lift the uterus up toward the abdominal hand, producing compression of the uterus

mum amount of anesthesia should be used during the repair of the perineum

Pituitrin as a rule is given after the placenta is delivered, lately ergotrate is given instead, or with it However, when the patient had been deeply anesthetized, the pituitrin is given immediately as the baby is born, even before the placenta is delivered, so as to counteract the relaxing effect of the anesthesia sooner

The fourth stage now begins, which is concerned primarily with the control of bleeding and secondarily with the repair of lacerations All repairs are done after the placenta is delivered

With the hand on the abdomen the nurse continues to hold the uterus after the placenta is delivered and makes pressure on it Two fingers of the right hand are inserted in the vagina in the anterior fornix, and pressure is made against the anterior wall of the uterus, the fingers push the uterus up against the hand on the abdomen (Fig 3) Or the fingers pass on each side of the cervix in the lateral fornices and compress the cervix

from side to side closing the cervix and at the same time pushing the uterus upward (Fig 4). Thus bimanual compression of the uterus is attained. Without the fingers in the vagina the abdominal hand only pushes the uterus down in the vagina in an empty cavity but does not compress the uterus. The vaginal fingers are held against the uterus, and pressure from above is continued until the uterus is felt to be well contracted. This method of vaginal examination and bimanual compression of the uterus is done practically as a routine in all deliveries. Before the fingers are removed all clots are removed from the cervix and vagina and the cervix and vagina are palpated to determine the extent of any and all lacerations.

When the uterus is very much relaxed and the bleeding is considerable the entire hand is inserted in the vagina and the fingers gather up the walls of the cervix and compress it from all sides, at the same time the uterus is pushed upward against the abdominal hand until compression of the uterus is attained (DeLee Fig 714). At frequent intervals the cervix is allowed to open up so that the accumulated blood can escape and the clots can be expressed. The uterus cannot contract properly while there are clots in it. The oxytocics are repeated if necessary. Contraction of the uterus and control of bleeding must be attained.

Bleeding below the clitoris should be promptly observed and must receive immediate attention as it may be very profuse. Pressure controls it temporarily until the tear is sutured.

When a vaginal hematoma is detected in the process of forming it should be incised. The vessels can then retract and the bleeding will cease or the bleeding area should be sutured. The vagina should be packed with iodoform gauze whether the hematoma is incised or not so as to produce pressure and thereby prevent its extension. When the patient complains of severe pain in the vagina radiating toward the rectum vaginal hematoma should be suspected.

Packing the uterus to control bleeding is not resorted to as it is not considered desirable. Although to pack a uterus is not a difficult procedure to pack it perfectly and completely is not simple. With whatever quantity of gauze the uterus is packed the uterus may still further relax as it is not a solid structure and the bleeding may not be controlled. On removal of the packing hemorrhage may recommence. It is unphysiological to pack the uterus as the means of controlling the hemorrhage is for the uterine muscle fibers to retract and contract and eliminate

the sinuses whereas if the uterus is packed the sinuses remain distended.

Packing the vagina is done very frequently. Its main object is to fill the empty cavity of the vagina so that pressure can be made on the uterus from above against something solid instead of an empty space. It also aids in controlling bleeding from the vagina or cervix. When the bleeding is more or less controlled by bimanual compression as has been described, and the uterus still has a tendency to relax, then the vagina is packed as a precaution against further bleeding. Packing is not done while the bleeding is still continuing. The bleeding must first be controlled by bimanual compression otherwise clots will be retained in the cervix and the uterus and induce more bleeding. Iodoform gauze (5 per cent) is used for packing. The gauze is 8 inches wide folded to one inch and ten yards long. It is put up in glass jars ready for use. The tubular packer (DeLee Fig 790) simplifies the procedure greatly. The packer used is  $1\frac{1}{16}$  of an inch in diameter, and has two prongs. It should vary in diameter according to the width of the gauze used.

Even in placenta previa it is not considered advisable to pack the uterus after delivery as the packing will distend the sinuses and maintain the bleeding. Packing the vagina compresses the cervix and with pressure from above contraction of the uterus and cervix is more likely to be attained.

The patient is kept in the delivery room until all bleeding is controlled and the uterus is well contracted. Frequently the patient is in bed 15 minutes after the birth of the child, and at other times she remains on the delivery table for an hour or longer.

The repair of the perineum is done after the placenta is delivered and the bleeding is controlled. For the technique of the repair of the perineum the reader is referred to the standard text books on the subject. DeLee's excellent illustrations describe all forms of repair. As little anesthesia should be used as is possible so as not to induce relaxation of the uterus. Cervical lacerations are not as a rule sutured as most tears which appear extensive shrink to insignificance when the cervix contracts.

In repairing second degree lacerations or epitriatomies I find it unnecessary to suture the different structures in separate layers. The superficial and deep structures are sutured together with the same stitch. I find that if the deep layers are sutured separately the catgut and the knot in the deep layer collect the lochia and interfere with the healing. Whereas when a through suture is

used for the superficial and deep layers, primary union is more apt to occur. The suturing can thereby be done much more quickly and be completed before the patient reacts from the previous anesthetic, without the need of prolonging it, or it may be done under first stage anesthesia. This does not apply to third degree lacerations, which require delicate repair of the different structures. By resorting to proper episiotomies third degree lacerations can usually be avoided. While the repair is being done the uterus should be held firmly and not allowed to relax. If it tends to relax, the repair should be interrupted and attention given to the uterus.

When the patient is placed in bed she still needs watching, as the uterus is still liable to relax. Abdominal binders are used postpartum, as the patients prefer them, but the binder is not put on for several hours after the patient has been in bed, so that the nurse can continue to feel the uterus. In watching the uterus the nurse must know what constitutes a firmly contracted uterus, otherwise an inexperienced nurse may be holding a uterus which may be filling up with blood and be under the impression that it is well contracted.

If the uterus relaxes when the patient is in bed, all clots must be expressed. If in doubt, vaginal examination is done again and the clots are removed from the cervix and vagina. When the vagina has been packed and it is found that serum runs out through the packing, it is a sign that blood clots are accumulating in back of the packing. If the uterus rises up or fresh blood is expressed or there are other signs of bleeding or even a suspicion of bleeding, the packing is removed, the clots are expressed, and the vagina is repacked. When the patient, after being in bed, continues to complain of cramps which are more severe than the usual afterpains they may be due to blood clots in the uterus. The removal of the packing, or vaginal examination or repacking can be done in bed if necessary. Sterile towels are used to drape the area, and with sterile gloves and the tubular packer, the vagina is repacked with iodoform gauze.

It is evident from this description that we do not practise watchful waiting for bleeding in the hope that the bleeding will cease by itself. Active measures to control bleeding must be taken promptly to avoid unnecessary or excess loss of blood.

In our entire series there were no deaths directly attributable to hemorrhage. The deaths that did occur from hemorrhage were in cases of placenta

prævia, and in one case of a bleeder in which the blood failed to clot and transfusion was of no avail.

It should be evident that the technique described and advocated ought to be effective in causing contraction and compression of the uterus and the control of bleeding. The great objection raised would be against doing vaginal examination, for fear of infection. The antagonism against vaginal examinations has reached the stage of a phobia or a superstition with many obstetricians. Conditions are overlooked, diagnoses are guessed at, and patients are neglected because of the unwarranted fear of making vaginal examinations. By the method described of managing the third and fourth stages, the blood loss is greatly reduced, our patients rarely require blood transfusions, and they make a better postpartum recovery. All the vaginal examinations are, naturally, done under aseptic precautions. There are absolutely no ill effects resulting from them. The morbidity is very low with no mortality from infection.

I consider vaginal examination in all stages of labor and the active treatment in the prevention and control of hemorrhage absolutely essential for proper obstetric practice.

#### SUMMARY

The term, third stage of labor, should be limited to the delivery of the placenta. The interval thereafter, between the delivery of the placenta and the time the patient is ready for bed, is designated as the fourth stage. It concerns itself primarily with the control of hemorrhage.

The placenta separates as soon as the baby is born. Vaginal examination is done and the placenta is promptly expressed. No ill effects result from vaginal examination.

Vaginal examination and bimanual compression of the uterus are done to control hemorrhage.

The vagina is frequently packed with iodoform gauze, but not the uterus.

The technique used for the third and fourth stages of labor, which gives very satisfactory results, is described.

#### REFERENCES

1. DELEE, J. B. *Principles and Practice of Obstetrics*, 6th ed. Philadelphia: W. B. Saunders Co., 1933.
2. LEFF, M. *Am. J. Obst. & Gynec.*, 1929, 18: 868.
3. SCHUMANN, EDWARD A. *Obstetrics*. Philadelphia: W. B. Saunders Co., 1936.
4. STANLEY, H. J. *Williams Obstetrics*, 7th ed. New York: Appleton-Century Co., 1936.

# FAT NECROSIS—GRANULOMA OF THE BREAST

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**T**HE importance of recognizing traumatic fat necrosis of the breast lies in the fact that clinically it closely resembles carcinoma.

The clinical criteria for the diagnosis or exclusion of malignancy in the breast fall short when confronted with a tumor in a middle aged woman, who is overweight and whose breasts are fatty. Such findings as hardness of a tumor, or one that is not circumscribed, showing attachment to the skin overlying it or retraction of the nipple in most cases justifies the clinical suspicion of cancer. Yet the same findings are seen in traumatic fat necrosis.

This condition was first brought to the attention of surgeons by Lee and Adair in 1920 (4) when they reported 2 cases. In 1922 they reported 3 additional cases (5) and in 1924 (6) they collected all known cases from their own clinic and other sources. This formed a group of 20 cases from which they drew the following conclusions: 'This condition occurs as a rule in middle aged individuals. In practically every incident the woman was far beyond the normal weight. As the disease occurs in unusually adipose individuals, the breasts are unusually large. Trauma was obtained in the history of 14 or 70 per cent of the cases. The tumor is painless and in the majority of the cases is stony hard. The tumor may be adherent to the skin overlying or to the deep fascia. The nipple may show evidence of retraction (occurring in 20 per cent of their cases).

Since the report of this group a number of isolated cases have been reported. Geoffrey Keynes was the first to call the attention of British surgeons to the existence of this condition when he reported the case of fat necrosis in a woman on whom a clinical diagnosis of cancer was made with a consequent complete amputation of the breast pectoral muscles and the axillary fat. Cecil Rowntree reported a case of fat necrosis in a woman in whom a provisional diagnosis of carcinoma or tuberculosis was made and an amputation of the breast was performed. Manville reported 25 cases of fat necrosis in which a pre-operative diagnosis of malignancy was made in 29 per cent of the cases. Thus clinically it is very often difficult to diagnose the condition

excepting as in one case reported by J J Levin in which the presence of a tumor followed a definite history of trauma namely after hypodermolysis.

The surgeon must become very familiar with the gross appearance of the tumor in order to avoid mistakes. Ewing states (6) "that the tumor is usually pale dull, grayish white homogeneous, and chalky in appearance. The outline of the gross lesion in carcinoma is generally much sharper than in fat necrosis which may fade off gradually into surrounding areas. Chalky points and streaks of fatty epithelium lying in firm translucent connective tissue are characteristic of infiltrating carcinoma. The same whitish points are present in necrotic or inflamed fat tissue but they are generally much broader and more irregular. Occasionally, one finds a whole fat lobule as large as a bean chalky and opaque from the proliferation of fat cells in inflamed fat tissue. Carcinomatous nodules in the breast are nearly always single, whereas traumatized fat is often very irregularly distributed and cicatrization appears in multiple points.

The microscopic section furnishes a correct interpretation at once from the presence of much cellular overgrowth, fibroblasts mingled with lymphocytes, empty spaces once filled with fluid fat (oil cysts) and many phagocytic giant cells and wide areas of proliferating fat cells.

Keynes in his report states fat necrosis of the breast is not a lesion of the mammary gland proper, but the fat which overlies or infiltrates the mammary gland in later life. Grossly the appearance of chalky whiteness of the necrosed areas of fat resembles fat necrosis seen in acute pancreatitis. Microscopically the presence of embryonic fat cells and multinucleated giant cells, stamps the tissue as necrotic fat. Two illustrative case reports of this condition are offered.

The first case described is particularly instructive because although it fulfilled all clinical criteria for a diagnosis of malignancy, it proved to be a benign lesion. The diagnosis made pre-operatively was carcinoma and a radical amputation was performed. The second case was seen soon after the first a correct pre-operative diagnosis was made, and excision of the lesion only was done.

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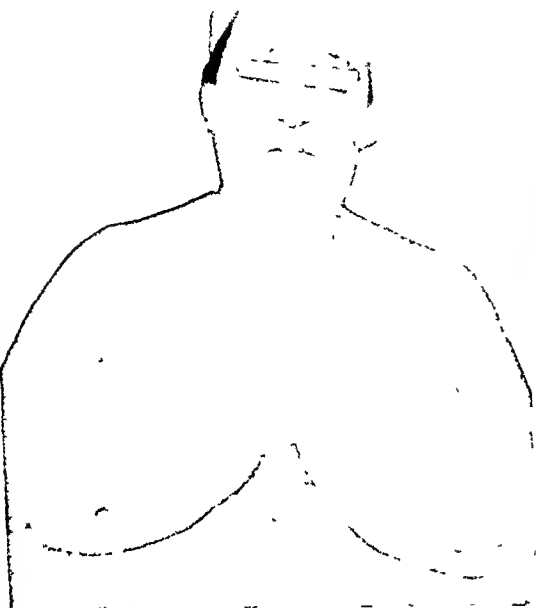


Fig 1 Fat pendulous breasts Retraction of right nipple



Fig 2 Intracanalicular granuloma  $\times 12$

CASE 1 No 188875 A short, stout, 53 year old woman was first seen in the out-patient department of the Jewish Hospital of Brooklyn on October 11, 1934. At that time a working diagnosis was made of menopausal syndrome and obesity, for which she was treated. On February 27, 1936, she returned to the clinic complaining of a lump in the right breast of 6 months' duration. This lump had never caused any pain nor had it increased in size. Within the past month the patient had been able to express a reddish brown, and sometimes bloody, discharge from the right nipple.

Physical examination revealed a middle aged, short, and rather corpulent woman. The breasts were large, fatty, and pendulous (Fig 1). There was a mass in the outer quadrant of the right breast about 4 centimeters from the nipple which measured 3.5 by 2.5 centimeters in size. It was firm, irregular in outline, not encapsulated and felt as though it were deep in the breast tissue. The overlying skin was adherent—and when the patient leaned forward, allowing the breast to sag, there was noticeable retraction and dimpling of the skin overlying the mass. The nipple was retracted (Fig 1). There were two small lymph nodes about 1 centimeter in diameter palpable high in the axilla which felt soft. No history of trauma could be elicited from the patient. A pre-operative diagnosis of carcinoma of the breast was made. Because of the soft consistency of the tumor, an element of doubt was cast on the diagnosis.

The mass was excised with a good portion of surrounding normal breast tissue. Sectioning imparted a gritty sensation to the scalpel. The cut section was brown-yellow in color, granular and firm. Although it did not have the typical cicatricial appearance nor the chalky points or streaks, nor the Bartlett pear appearance which is characteristic of carcinoma, the clinical conception of this case

more than the unusual appearance of the cut section, made one feel that a radical operation would be the safer procedure. The remainder of the breast, pectoral muscles, and axillary contents were removed. The patient made an uneventful recovery and was discharged.

*Pathological report, gross.* The specimen consists of a breast and associated structures. One surface is covered by an elliptical portion of skin, 21 by 20 centimeters, including the nipple. Lateral to the nipple is a gaping aperture, 8 by 4 by 3 centimeters. The underlying adipose tissue is 6 centimeters thick and attached to the posterior surface is a portion of muscle tissue, 17 by 9 centimeters. Attached to one edge of the specimen are several, firm lymph nodes measuring up to 1.5 by 1 by 1 centimeter. Their cut surfaces are pale gray and bulge. Sections through six of these were taken for microscopic study. Corresponding in shape and size to the cavity and received separately, was a portion of firm, yellow and white tissue, 7.5 by 4 by 3 centimeters. It is composed of circumscribed areas of dense, white and gray tissue. In the cut surfaces, spaces up to 0.3 centimeter are filled with firm, brown and white tissue. In one area strands of dense white tissue in a branching arrangement are noted.

*Microscopic.* Large lumina of ducts and acini, filled with a cellular debris, are lined by cuboidal cells with nuclei heaped up into several rows. In places the epithelium is desquamated and in the surrounding loose and dense fibrous connective tissue there are large mononuclear cells containing light staining foamy cytoplasm, with small eccentrically placed nuclei and small round cells. In some areas, parts of ducts are seen in a dense and hyalinizing fibrous connective tissue. Scattered through the connective tissue are large mononuclear cells containing rusty brown granules. Many of the ducts are distorted by the prolifera-





Fig 3 Granuloma showing detail  $\times 148$



Fig 4 Same as Figure 3  $\times 500$

tion of the surrounding connective tissue. No atypical proliferation of the epithelium is seen anywhere in the preparation. Occasional groups of epithelial cells, parts of lumina of ducts or acini are seen in the dense hyalinizing fibrous connective tissue stroma. Occasional groups of lumina are lined by flat cells. In the center of some larger area amidst the large mononuclear cells there are slit like structures. In another area there are many giant cells of the foreign body type. In a third preparation a large lumen is seen with frequent infoldings. The surface is partly covered by epithelium and partly denuded. The connective tissue stalks appear like granulation tissue and are loose and densely infiltrated with polymorphonuclear leucocytes and large mononuclear cells. Several such lumina are noted.

In one of the larger lumina there is a dense hyalinizing fibrous connective tissue with many giant cells of the foreign body type and large mononuclear cells with granules of rusty brown pigment. Serial sections show the central mass to be attached to the wall of the duct by a broad pedicle and entirely covered by flattened epithelium proving it to be an invagination. It obviously is a granuloma which occupies the lumen of the duct in the same way as does an intracanalicular fibroadenoma (Fig 2). In another section (Fig 3) small individual complexes can be recognized consisting of a central matrix of spindle cells with small compact oval nuclei. Lying in this mass, and arranged radially are a number of oval or fusiform clefts adjacent to which are giant cells of the foreign body type (Fig 4). Surrounding these structures are diffuse collections of small round cells. These aggregates lie in the adipose tissue. Beneath the epithelium of the ducts and in

the surrounding tissue there is considerable infiltration with polymorphonuclear leucocytes and newly formed fibrous connective tissue. Preparations from the lymph nodes show looseness in texture, marked overgrowth of the germinal centers of the lymph follicles, proliferation of the sinus cells, and an engorgement of the sinuses with small round cells, large mononuclear cells, some pink staining material and many eosinophiles.

#### Diagnosis Fat necrosis of breast

CASE 2 No 189832 A 46 year old woman was admitted to the Jewish Hospital of Brooklyn on April 6, 1936 with a history of a lump in the right breast for the past 3 weeks. Occasionally she experienced a sticking sensation in the right breast.

In August 1932 the patient complained of pain in her lower back. An x-ray examination of the lumbosacral region revealed an osteosclerosing type of infiltration of the fourth and fifth lumbar vertebrae and upper border of the sacrum. At that time a study of the remainder of her osteous system was suggested in search for other malignant foci.

She returned to the clinic in October 1935 when her chief complaint was pain in the right upper quadrant. A diagnosis was made of chronic cholecystitis. A cholecystographic study revealed a solitary calculus and a poorly functioning gall bladder. She was admitted to the hospital and a cholecystectomy was performed. The pathological report was cholecystitis chronic with cholelithiasis.

Examination on her last admission revealed a middle aged obese woman with fat heavy pendulous breasts (Fig 5). In the lower inner quadrant of the right breast was a mass of stony hardness about 5 cm in diameter.

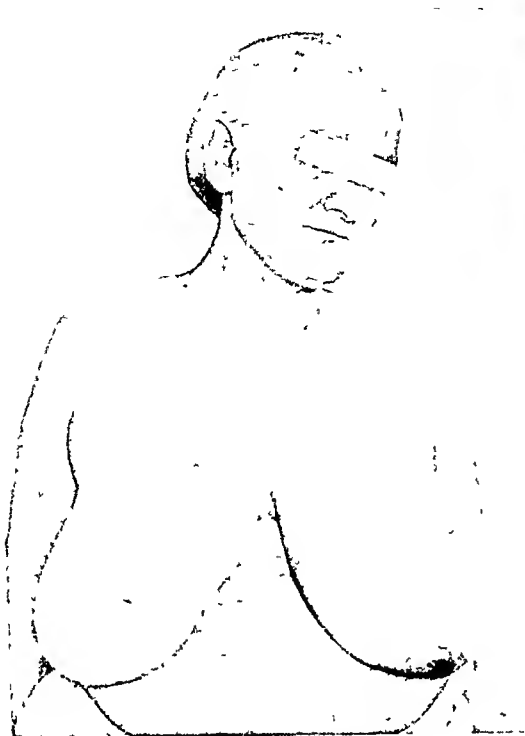


Fig 5 Fat pendulous breasts



Fig 6 Roentgenogram of mass in breast

eter, fairly well circumscribed, freely movable, and not adherent to the overlying skin or to the deeper structures. This mass was situated deep in the breast tissue. The working diagnosis was that of cyst, with calcification. An x-ray examination of the breast revealed a well circumscribed calcified area (Fig 6). An x-ray film of the skull failed to reveal any evidence of metastasis; there was calcification of the sella turcica. A restudy of the lumbosacral region showed no evidence of pathology in the fourth or fifth lumbar vertebrae. The calcium and phosphorous content of the blood were 11.0 milligrams per cent and 3.8 milligrams per cent, respectively. The cholesterol content of the blood was 308.0 milligrams per cent. Roentgenograms of both humeri were normal. The tumor was excised with surrounding normal breast tissue, under gas oxygen anesthesia. The patient made an uneventful recovery and was discharged cured.

*Pathological Report, gross* The specimen consists of two portions of lobulated yellow tissue, 9 by 9 by 3 centimeters and 8 by 6 by 1 centimeter, respectively. In the larger (Fig 7) there is a firm egg shaped mass, 7 by 4 by 2 centimeters. The cut surface of the mass shows it to be composed of a central core of soft, yellow tissue surrounded by a rim of firm white material which in places resembles cartilage. In the nearby adipose tissue there are circumscribed areas of yellow tissue resembling that noted in the mass.

*Microscopic* In adipose tissue there are occasional groups of mammary gland acini and ducts. In nearby areas there is a dense hyalinizing fibrous connective tissue and extensive areas of adipose tissue with many large cells with foamy cytoplasm and round nuclei. In some areas there is pink staining homogeneous material and surrounding this

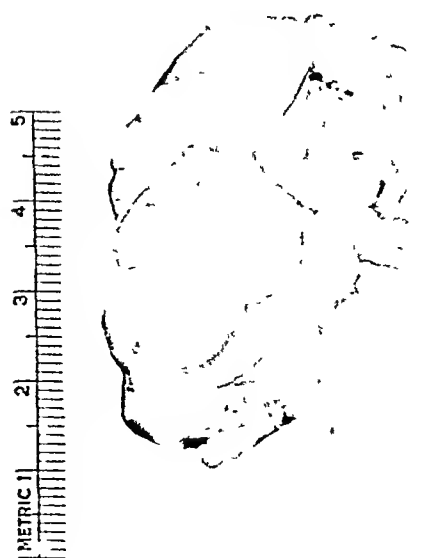


Fig 7 Mass from breast

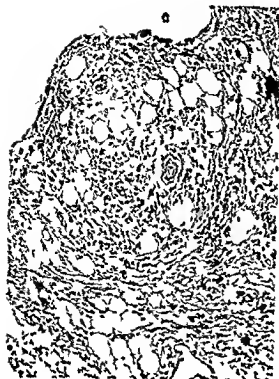


Fig 8



Fig 9

Fig 8 Granuloma showing detail  $\times 15$ Fig 9 Same as figure 8  $\times 50$ Fig 10 Calcium deposit in wall of granuloma  $\times 40$ 

Fig 10

and nearly there are occasional giant cells of the foreign body type and a lesser infiltration with small round cells and large mononuclear cells. In another preparation there is a broad zone of pink staining fibers with no nuclear stain. Nearby there are collections of cells with granular staining, foamy cytoplasm and round eccentrically placed nuclei of similar cell filled with rusty brown granules (Fig. 11). Coarse collagenous bundles are seen connecting with the dense hyaline area. In the meshes of the collagen bundles with no nuclear stain there are a number of large multinuclear cells with golden yellow granules in the cytoplasm.

*Sitapnosus Mammary gland with fat necrosis*

If one were to speculate regarding the cycle of evolution of fat necrosis it can be said that first there is trauma either from external causes or direct pressure of the breasts from their own weight. If the trauma is severe with injury to blood vessels one may see areas of ecchymosis. If the trauma extends more deeply there may be no visible evidence of blood extravasation. The presence of pigment in cells as seen in the section (Figs. 2-8) suggests that there has been hemorrhage.

It is a well known fact that there is a fat splitting ferment (lipase) in the blood as well as in the

fat itself Fat tissue being unstable breaks down very easily into its constituents, fatty acids and glycerine Fat necrosis and fat splitting are two quite different processes, frequently allied, necrosis being the principal event and fat splitting only an accompaniment

Two possible theories of fat necrosis are mentioned by Farr (1) Enzyme action from liberated blood or from the fat cell itself, (2) Simple pressure necrosis from anemia with secondary fat splitting Probably both factors take part in the process, but it is not necessary to postulate enzyme action at all for its production In his conclusion he states that possibly no ferment action is concerned, the etiological factor being simply ischemia Hatfield is one of those who holds firmly that fat necrosis is produced by sterile autolysis

The necrosis of fat tissue accompanied by a splitting into fatty acids and glycerol is considered as a degenerative phase which is closely followed by repair This repair is characterized by the appearance of spindle, round, and giant cells (Menville) In the first case described, the process of repair had gone on to the stage of fibrosis, causing a large hard tumor, which produced a retraction of the nipple The explanation is that since the majority of fat necroses are subcutaneous, the fibrous repair tissue acts like strong cords which have no elasticity but have a tendency to retract In the second case, the end-result of fat necrosis is cyst formation with calcareous deposits Adair states that early in the cycle of fat

necrosis, small cysts may form. After several years these cystic cavities may contain a mixture of small and large calcareous masses If these tumors be left undisturbed, the entire cyst contents and cyst wall becomes a solid calcareous mass

#### SUMMARY AND CONCLUSION

- 1 Two cases of traumatic fat necrosis are reported
- 2 Fat necrosis must be included in the differential diagnosis of breast tumors
- 3 Clinically fat necrosis more closely resembles carcinoma than other benign lesions
- 4 The treatment is local excision of the tumor mass
- 5 A correct diagnosis can often be made if the surgeon clearly understands and keeps in mind the gross appearance of the lesion

Since writing this article, the diagnosis of fat necrosis granuloma was made in 2 cases before operation, and in both cases the patient was spared radical operation of the breast because of frozen section of a biopsy specimen

#### BIBLIOGRAPHY

- 1 FARR, CHARLES E Ann Surg, 1923, 77 513
- 2 HATFIELD, GEOFFREY Brit J Surg, 1925, 13 742
- 3 KEYNES, G Brit J Surg, 1925, 48 663
- 4 LEE, B J, and ADAIR, F E Ann Surg, 1920, 72 188
- 5 Idem Surg, Gynec & Obst, 1922, 34 521
- 6 Idem Ann Surg, 1924, 80 670
- 7 LLVIN, J J J M Ass South Africa, 1931, 5 552
- 8 MENVILLE, JOHN G Am J Cancer, 1935, 24 795
- 9 ROWNTREE, C Lancet, 1925, 11 1065



# AN IMPROVED, RADICAL TECHNIQUE FOR REPAIR OF HYDROCELE TESTIS

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**T**HROUGH some years of observation and experience in the radical repair of hydrocele testis the author has endeavored to determine the cause of the marked postoperative swelling and induration to be found in the e cases. This complication occasions prolonged hospitalization (not less than 10 days) notwithstanding meticulous postoperative care by elevation of the scrotum and the application of cold or heat. A suspensory of sufficient size is unobtainable.

As so little trauma is caused by the enucleation of the sac and testis in the Wyllis Andrews (botle operation) technique (2) or the numerous procedures described by Bickham, it is reasonable to conclude that in the uncomplicated (non infected) cases there must be some disturbances in the circulatory and lymphatic systems, sufficient to cause the marked reactions encountered. Muschat's work on "Testicular Torsion" would seem to corroborate this idea as does later work by McKenna and Ewert on "Management of Undescended Testis."

In 1932, the author began experimentation with radical procedures, incompletely enucleating the sac and testis by freeing only the anterior half or two-thirds of the sac without detaching the gubernaculum.

The following technique was finally adopted. (1) The sac is partially separated from the fascial planes and opened to evacuate the contents. Fig. 1a—the dotted lines mark the portion of the anterior wall in process of excision. (2) Interrupted, interlocking figure of eight sutures are placed around the edges, their ends being grasped in forceps and the sutures not being tied until all have been placed around the whole cut edge of the sac (Fig. 1b). These figure of eight sutures act as hemostatic agents and when properly tied contract the sac wall about the epididymis and posterior surface of the testis. When the figure of eight sutures are tied, the one at the lower pole of the testis (gubernaculum) is tied first then that on each side alternating until all sutures have been tied. An assistant should make slight pressure against the testis through the posterior scrotal

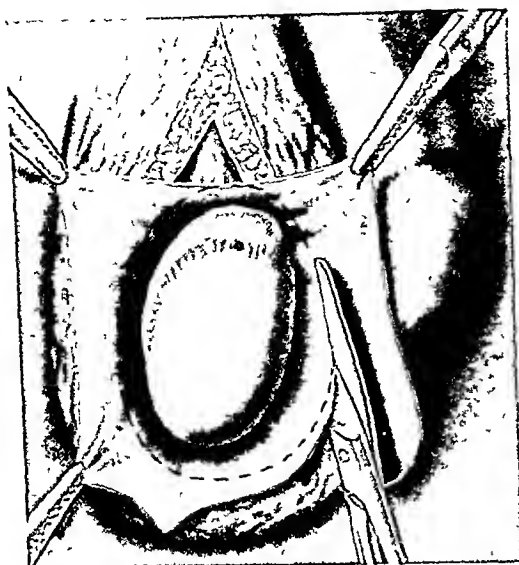
wall in order to elevate the testis during the tying of the sutures. (3) Figure 1c illustrates the appearance of the incomplete repair of the sac wall with traction forceps on the lower mesial portion. The infundibular (deepest) fascia is noted with tunica (sac wall) in the partially tied figure-of-eight suture. (4) The dartos and skin are closed with a continuous, running suture (Fig. 1d). More recently a continuous mattress suture has been used for the skin closure. Hemostasis is essential for success, notwithstanding the fact that only an occasional ligature is required in the dartos. Plain No. 0 catgut is used throughout.

Local infiltration with novocain solution  $\frac{1}{2}$  per cent was discontinued after the first 6 cases because of the edema in the scrotal wall although there was no induration or swelling of the testis. Eutocain, 50 milligrams boiled in 2 cubic centimeters normal saline solution, as a spinal anesthetic was next used with gratifying results. More recently an epidural injection of novocain, 2 per cent 20 to 30 cubic centimeters has been used with much less risk. In one of the early cases, in a child, in which interrupted hemostatic mattress sutures and not figure-of-eight sutures were used under ethylene anesthesia recurrence was reported.

In the uncomplicated cases, under spinal epidural or gas anesthesia, a medium sized suspensory may be applied and the patients may be allowed out of bed and be discharged from the hospital in 36 to 72 hours after operation without induration or swelling of the testis.

In 28 cases in which the interrupted interlocking figure of eight sutures were used 19 replies report no recurrences. One patient reporting partial recurrence has since been examined and no indication of fluid in the scrotum was found. One subsequent report has been received showing no recurrence giving a total of 20 replies to 28 questionnaires without a single recurrence.

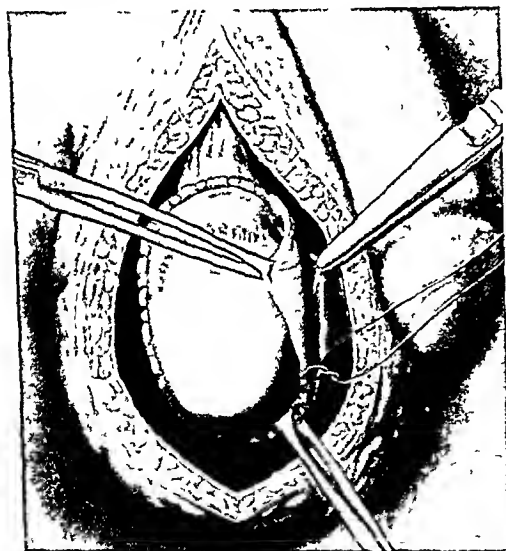
The author has had the opportunity to explore one of his first cases operated upon by this procedure 4 years previously. On this occasion the patient presented large bilateral masses in the scrotum which were irregular, firm, and nodular, and which transmitted light. The masses proved to be spermatoceles. It was very interesting to



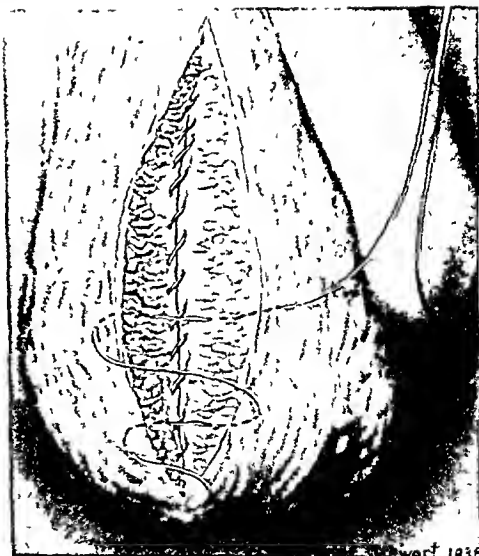
a



b



c



d

Fig 1 a, Anterior half of sac exposed b, Interrupted interlocking figure-of-eight sutures in sac wall c, Appearance of repair of sac wall d, Closure of dartos layer of skin

note the result of the previous hydrocele repair. The surface of the tunica vaginalis was smooth and glistening, with considerable thickening behind the testis, where it had been drawn along the vas and lower end of the cord.

#### SUMMARY

- 1 A new, radical technique for repair of hydrocele testis is reported.
- 2 Epidural or spinal anesthesia is preferred for adults.

3 Following exposure and excision of the anterior half or two-thirds of the sac, interrupted, interlocking figure of eight sutures are applied to sac edges. The dartos and skin are closed with continuous sutures.

4 Patients are able to walk out of hospital, wearing medium sized suspensories, within 36 to 72 hours after operation.

5 In a series of 28 cases, 20 questionnaire replies, including 1 case explored 4 years after operation, show a perfect result.

The author wishes to express his profound appreciation to Mr. W. Branks Stewart, artist, Louisiana State University Medical Center for the drawings, and to Miss Nan Gayle Hopkins, Social Service Department, Charity Hospital for her interest in the questionnaires reporting results.

#### REFERENCES

1. BICKHAM'S OPERATIVE SURGERY 1924 5 901-913
2. KEYS SURGERY 1909 4 607
3. MCKENNA AND IWERY J. Am. M. Ass. 1935 10, 1172-1175
4. MICHAIL SURG. Gynec. & Ob. 1932 54 759-63

## FOLLOW-UP OF HERNIA REPAIR

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**R**EPORTS of the results of the operative treatment of hernia from hospitals and surgical clinics are frequently seen in the surgical journals. Preceding the last quarter of the nineteenth century the recurrence of hernia following operation was the usual result. Halsted (17) in a paper quotes from an article written by Bull in 1890, at this time two methods of repair are being used with nearly equally poor results. Bull from 1883 to 1885, operated for the cure of hernia by what he called Socin's method, namely ligature and excision of the hernial sac and from 1885 to 1889 he employed Bank's method which consisted of ligature and excision of the sac plus suture of the pillars of the external ring. Recurrences were noted in 27.7 per cent of the cases repaired by Socin's operation and in 40 per cent of those treated by Bank's procedure. These recurrences were all noted in the first year after operation. In 1890 Halsted (15) reported the operation which now bears his name. This paper was shortly followed by a similar article by Bassini (2) and in 1895 Ferguson (10) summarized the methods of surgical procedures for the cure of inguinal hernia which were in vogue at that time. He also gave his modifications of the Bassini and Halsted techniques and in the same paper reported a technique for the cure of femoral hernia. Since the publication of these papers the reported incidence of recurrence of hernia has been fairly uniform, ranging from a low of 1 per cent at the Mayo Clinic

(22) to figure, covering a fairly wide range above this. With Bassini's and Halsted's procedure as a groundwork, operators have at various times introduced modifications and changes in the detail of the technique. These changes have met with indifferent success. Bloodgood in a review of cases done with the Halsted technique reported recurrence of 5.2 per cent. Since this early report very few summaries have shown much if any improvement.

The cases in this report are those in which operation for the cure of hernia was done in the First and Second Surgical Divisions in the Presbyterian Hospital in New York City. Only those cases with a follow up by examination of patients in the Vanderbilt Clinic will be included in an analysis of the statistics. Private and semi-private cases are excluded as their follow up data are very incomplete and in many instances entirely lacking. The types of hernia discussed are inguinal, femoral, umbilical and epigastric. Ventral incisional or postoperative hernias are not included.

It is important to know the method employed in following the cases after discharge of patient from the hospital to evaluate correctly post-operative results. Many writers fail to mention the system of checking their cases, while others apparently include written reports either from the patient or some outside physician. The inaccuracy of this latter method is clearly shown in a series which reports a recurrence of 3.4 per cent in the cases followed by letter as against an 8.3 per cent recurrence in the patients which were examined in their own follow up clinic. With such

discrepancies occurring it is obvious that the only reliable method of obtaining accurate information of the end-results of herniorrhaphies is by adequate and complete examination of the patient.

All of the patients treated in the wards of the Presbyterian Hospital are, upon discharge, given an appointment to return to the follow-up division of the Vanderbilt Clinic, which is the outpatient department of the hospital. Here, they are interviewed and examined with three main objectives in mind: anatomical result, symptomatic result, and economic result. Accordingly the findings of each of the three points are given a score ranging from 1 to 4, a 444 result being the highest possible. The patients in this series were in most instances examined by the surgeons who performed the operation. This, however, was not always possible, consequently many of the patients were checked by more than one surgeon. With the exception of instances in which it is important to include those who failed to keep their appointments in the follow-up clinic, only the patients so followed are included in the analysis of the figures. For convenience and to avoid confusion, all hernias, irrespective of complications which would give them a lower score, will be designated as a 444 result in the tables and elsewhere, unless there is recurrence, in which case it will be scored as either "recurred" or "rec" instead of the usual 044.

This series includes 752 patients operated on for hernia during the 6 year period between January 1, 1930, and December 31, 1935. These patients are all adults as those under 12 years of age are operated on in the Babies Hospital. A total of 925 hernias were repaired, all but 88 of which returned for follow-up examinations. 827 were seen at least once, 589, or 72.3 per cent, returned over a period of 12 months, and 338, or 41.5 per cent were followed at least 24 months. Sixty-six, or 8.2 per cent, of the hernias have a follow-up period of 5 years or longer. In this series the postoperative interval between repair and the time of recurrence is somewhat longer than those given in other reports. Judd found that 70 per cent of his recurrences were noted in the first 6 months and 90 per cent in the first 12 months. Erdman, in 1923, reports that 73.9 per cent of his recurrences took place in the first 12 months and 98.6 per cent in the first 24 months. In our cases 72 per cent of the recurrences were noted at the end of 12 months and 87.2 per cent of the recurrences within the first 24 months.

The surgical procedures in these cases were performed by 60 different surgeons, 38 of them being the senior house officers serving their last

4 months as interne, the 22 remaining operators being members of the attending staff. The senior house officer is assisted by a member of the attending surgical staff in every operation. In comparing the two groups of operators it was found that the cases operated on by the attending surgeons had a 6.3 per cent recurrence as against a 6.8 per cent recurrence in those repaired by the members of the house staff.

The difference in the percentage of recurrence as related to the type of anesthesia used in the operation is very small. general anesthesia, 7 per cent, spinal anesthesia, 7.5 per cent, local anesthesia, 8 per cent. In 9 cases the anesthesia record was not on the chart. It is interesting to note 2 recurrences in this group. In his report, Taylor found the incidence of recurrence higher in those cases repaired with local anesthesia, adding that a local anesthetic does not interfere with or delay wound healing. Davis reports the low figure of 2.3 per cent recurrence in hernias repaired with local infiltration or nerve block anesthesia.

That the operation for hernia carries a minimal risk of fatality is probably very true. Taylor, in 1920, reports 2,486 cases of inguinal hernia with 19 deaths, or 0.76 per cent. Davis reports 8 deaths in a series of 1,756 for a 0.44 per cent mortality, while Erdman reports a low mortality of 0.32 per cent. In this series there were 10 deaths in 752 patients which gives a 1.3 per cent mortality. In the simple or not strangulated group there were only 5 deaths, or 0.69 per cent, as against 17.8 per cent in the strangulated group. Eight of the 10 deaths occurred in patients over 50 years of age, the 2 others being in patients of 35 and 38 years of age. Eight of the patients died after the tenth day, 2 on the twenty-third day, both of which had been transferred to the medical wards, one in cardiac decompensation, the other following repeated coronary attacks. There are 4 cases of acute hernia which had been strangulated 24 hours or longer, 3 of which had to have intestinal resections. Some of the complications noted as contributory factors interfering with recovery are cardiorespiratory failure, 1, coronary occlusion, 1, cardiac insufficiency, 1, ileus, 1, pancreatitis, 1, gastro-intestinal hemorrhage, 1, peritoneal abscess, 1, and pneumonia, 2.

In spite of repeated statements that the operative cure of hernia is nearly an ideal surgical procedure, in that the results are good and the mortality so low as to be negligible, the mortality statistics in this series are sufficiently high to warrant serious consideration of all factors pertaining to the general condition of the patient and



TABLE A — RESPIRATORY COMPLICATIONS

Respiratory	444	Recurred
Upper respiratory infection	10	—
Cough	23	2
Pneumonia	27	2
Atelectasis	17	1
Pleurisy	3	—
Infarct, pulmonary	1	—
Massive collapse	1	—
Bronchitis	3	—
Tracheitis	1	—
Pneumothorax	1	—
	89	5

TABLE B — COMPLICATIONS OTHER THAN RESPIRATORY

Other Complications are —	444
Pain in scar	12
Thrombophlebitis	7
Swelling of testicle	6
Atrophy of testicle	4
Keloid in scar	1
Scrotal swelling	3
Ileo pectoneal bur stis	1
Epididymitis	1
Painful testis	2
Hydrocele	5

a careful weighing of the benefits to be derived in the case in hand before suggesting an operative repair. It serves to re-emphasize the fact that even the simplest surgical procedures carry a sufficient risk, so that they should be advised only after considering all the facts concerned.

It has already been mentioned that the patients in this series fall into the so called adult group. It has long been known that patients of indirect inguinal hernias appear for operation at a younger age than do patients with other types of inguinal or femoral hernia. In the indirect group 65 per cent of the patients were under 35 years of age and only 26 per cent were over 45. Fifty one per cent of the patients with direct inguinal hernias were under 35 years while 46 per cent were over 35. The other groups of inguinal hernias, namely sliding and indirect direct, fall into an intermediate age group.

The serology was determined in 667 patients, 30, or 4.49 per cent, had a 4 plus Wassermann reaction, 2 of which had a recurrence of their hernias. There are 257 cases in which the Wassermann reaction was either not reported or reported as equivocal. A truss was worn for 287 of the hernias, 26 of the hernias which recurred had at some time or another been supported by a truss. The percentage recurrence of those who had worn a truss was 9.3 which is slightly higher than that for the entire group. The weakening and scarring of tissues which is associated with the cases of hernia which had been supported by a truss was also noted in these cases. Two patients gave a history of having worn a truss from childhood for a hernia which was present at that time. Both these patients were later admitted for a repair of a hernia on the side opposite to that for which a truss had been worn and in neither case was a hernia noted on the side which had been treated by the wearing of a truss.

Wound infections were noted in 53 cases with follow ups on all but 2. Most of these infections were trivial or stitch abscesses, the latter being

so designated in 20 wounds. Only 2 of the infections were listed as serious. Twelve or 2.55 per cent of the cases repaired with silk showed some infection while 37, or 15.04 per cent of the cases repaired with catgut were infected. Hematoma was noted in 17, or 1.8 per cent of the wounds, all but 3 of which were followed and no recurrences noted. Silk was the suture used in 12 of the cases with hematoma. This gives a 2.3 per cent of the total cases repaired with silk. Five or 2.3 per cent repaired with chromic catgut developed a hematoma.

Detail analysis of the cases repaired under local anesthesia shows some interesting facts. In 107 cases local anesthesia was used either by itself or in combination with a general anesthesia. Three deaths occurred in this group. In 83 cases in which operation was done under local anesthesia the suture material was either silk or catgut. In the 54 repaired with silk alone there were 1 infection, 4 hematomas and 1 recurrence while in the 59 cases repaired with catgut there were 6 infections, 4 recurrences and no hematomas.

The frequency of other postoperative complications and their relationship to the incidence of recurrence are given in Tables A and B. The appendix was removed at the same time and through the same wound in 6 cases of right inguinal hernia with 1 recurrence. 16 hydroceles were excised, the wall of the intestine was pierced with a needle in 2 instances, the bladder was accidentally opened in 3 cases, in 3 cases the vas was accidentally cut, 4 cases had an orchidectomy and vasectomy and in 1 case the vas was crushed. In addition there were 2 cases of undescended testicle and 8 with the varicocele.

Of the 925 hernias Table I 816 belong in the inguinal group with a follow up on 734. 703 were in males and 86 in females, the ratio of almost 9 to 1. In the female group the hernias are divided as follows: 71 indirect, 7 direct, 2 indirect direct, 1 sliding and 5 in the recurrent group. There are 62 femoral hernias, all but 5 of which returned to

TABLE I—ANALYSIS OF CASES

	Male	Female	Total	Not followed	Recurred	Died	Not followed per cent	Re-curred per cent	Died per cent
Indirect	463	71	534	60	26	1	11.2	5.6	0.18
Direct	114	7	121	6	8	—	4.9	6.9	—
Indirect and direct	54	2	56	7	5	—	12.5	10.2	—
Sliding	28	1	29	2	4	1	6.8	15.3	3.4
Indirect recurrent	46	2	48	7	5	1	14.5	12.2	2.08
Direct recurrent	25	3	28	—	3	1	—	10.7	3.50
Femoral	11	51	62	5	3	1	8.0	5.4	1.6
Umbilical	2	7	9	—	—	—	—	—	—
Epigastric	7	3	10	—	1	—	—	—	—
Inguinal strangulated	13	5	18	1	1	3	5.5	5.8	16.6
Femoral strangulated	3	7	10	—	1	2	—	10.0	20.0
Totals	766	159	925	83	57	10	9.6	6.8	1.08

the clinic for examination, making a total of 57 followed cases. In the umbilical and epigastric group there are 19 cases, 9 male and 10 female. There are 28 strangulated hernias, 18 of the inguinal type and 10 in the femoral group, the male to female ratio remaining about the same as in the other groups.

The 816 inguinal hernias are divided into the 6 following groups: the indirect group of 534 hernias, with 473 followed cases, 121 direct inguinal hernias with 114 followed cases, 56 indirect-direct inguinal hernias with 49 followed cases, 29 sliding hernias with 26 followed cases, 76 combined hernias with 67 followed cases. The incarcerated hernias are included with the reducible hernias of their respective types. However, the acute or strangulated hernias are listed separately and will be discussed later. Recurrences are found in 26 or 5.6 per cent of the indirect inguinal hernias,

8 or 6.9 per cent of the direct inguinal hernias, 5 or 10.2 per cent of the indirect-direct inguinal hernias, 4 or 15.3 per cent of the sliding hernias, 8 or 11.9 per cent of the recurrent hernias.

Bilateral and double hernias occurred in 152 or 20.7 per cent of the patients. In this paper the term double hernia is limited to designate those cases of bilateral hernia in which the hernias were different one from the other on either side. There are 101 patients with bilateral hernia and 37 with double hernia. These figures do not give the correct incidence of bilateral or double hernia, for in addition there are 67 patients who had a hernia on the side opposite to that which was repaired in this series. There are also an additional 12 cases of double hernia in which one or both sides belonged in the recurrent group, 2 cases in which a double hernia was found on the same side. These last 2 cases were both direct inguinal her-

TABLE II—SUTURE MATERIAL

	Total			Chromic catgut			Silk		
	443	Rec	Rec per cent	444	Rec	Rec per cent	444	Rec	Rec per cent
Indirect	447	26	5.5	156	17	9.8	272	6	2.16
Direct	107	8	6.4	19	3	13.6	85	4	4.40
Indirect and direct	44	5	10.2	12	3	20.0	32	2	5.8
Sliding	22	4	15.3	9	3	25.0	14	1	6.6
Indirect recurrent	35	5	12.5	11	3	21.4	24	2	7.6
Direct recurrent	24	3	11.1	6	2	25.0	15	1	6.2
Femoral	53	3	5.5	26	2	7.1	25	1	3.5
Umbilical	9	—	—	5	—	—	4	—	—
Epigastric	10	1	9.9	2	1	33.3	9	—	—

TABLE III — BILATERAL HERNIAS

Bilateral hernias		One admission		Two admissions
		One operation	Two operations	Two operations
Indirect inguinal	441	46	8	9
Recurrent		4	—	3
2 slides		1	—	—
Direct inguinal		14	9	—
Recurrent		—	—	—
2 slides		1	—	—
Indirect recto inguinal	441	3	—	—
Recurrent		1	—	—
Double inguinal	441	13	8	4
Recurrent		2	—	3
2 slides		—	2	—
Femoral	441	3	—	—
Total		83	26	17

nias with associated femoral hernia. Table III gives the number and frequency of recurrence as found in this series of bilateral hernias. Bilateral hernia occurred 70 times in the indirect inguinal group and 24 times in the direct inguinal hernia group. There are no cases in which a sliding hernia was bilateral, but it did appear in 7 of the double hernias. Table IV separates and gives the relative frequency of double hernia and also indicates the most frequently found combinations of double hernia.

The analysis of the cases of bilateral and double hernia is divided into three groups as illustrated in Table III. Recurrent hernias are not included in this table. In the first column the patients who had both sides repaired at one operation are listed while the middle column gives those repaired at separate operations on the same hospital admission, and column three lists those who had either side repaired on separate admissions. In the first of these groups 9 or 53 per cent of the hernias recurred in the second group 2 or 38 per cent and in the last group 4 or 117 per cent, recurred. This series is too small for definite conclusions but seems to indicate that those which were repaired at separate operations had a better prognosis.

Transverse and Judd incisions were used in 16 cases, recurrences being found in 3 of them. There were 6 wound infections in the cases of bilateral hernia which were repaired at one operation and

TABLE IV — DOUBLE HERNIA

Co-existent with	Double hernia			
	Indirect	Direct	Indirect recurrent	Direct recurrent
Indirect	—	—	2	2
Direct	7	—	—	1
Indirect and direct	7	5	—	—
Sliding	4	3	1	—
Femoral	3	4	1	—
Umbilical	1	1	—	—
Epigastric	1	—	—	—
Indirect recurrent	—	—	1	1
Direct recurrent	—	—	1	—

5 infections of those which were repaired at separate operations. Three of these infections were in cases which had recurrences of the hernia and these belong to the group in which the operations were performed on different occasions. As there are so few cases in this series of bilateral hernia any attempt to correlate, with the incidence of infection, would only be misleading whether or not both hernias were repaired at the same operation or at separate operations.

Suture material in hernia repair has been much discussed in the literature. The points which have been emphasized is the necessity of having a material of sufficient strength and durability to hold the wound together over a long enough period of time to allow it to heal solidly. The separation of the line of repair has been given as one of the most frequent causes of recurrences. Halsted varied his choice of suture material, however most of his hernias were repaired with silk. He reported one series in which he used silver wire exclusively. Table II gives the number of hernias repaired with either chromic catgut or silk with the incidence of recurrences of each. This table does not include hernia which were repaired with chromic catgut and silk combined, linen or linen and chromic combined. Silver wire was used on one occasion. Irrespective of the type of hernia a marked and impressive lower incidence of recurrence is found in the cases repaired with silk as compared with those repaired with chromic catgut. In our series silk was used in 496 hernias, 34 per cent of which recurred. Chromic catgut was used in 2,0 with 125 per cent recurrent. In the direct inguinal group 89 of the hernias were repaired with silk and 22 with chromic with 449 and 136 per cent recurrences respectively. There were 15 indirect inguinal hernias repaired with silk and

TABLE V — MISCELLANEOUS FACTS

	Wassermann				Transversalis fascia						Fascia strips						Truss	
	++++		Not Recorded		Repair		Suture to Poupart		Plicate		External oblique		Lata		Rectus			
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
Indirect—444	19	5.6	144	29.7	54	11.2	153	31.8	83	17.2	34	7.6	15	3.2	7	1.4	121	25.1
Indirect—Rec	1	4.5	11	36.6	4	6.9	9	5.5	8	8.7	3	8.1	5	15.0	2	22.2	15	11.0
Direct—444	3	3.0	31	24.3	13	10.1	22	7.1	49	38.2	24	18.6	21	16.3	2	1.5	70	54.6
Direct—Rec	1	11.0	4	30.3	1	7.1	5	18.4	1	2.0	1	4.0	3	12.6	—	—	3	4.1
Indirect and direct—444	—	—	11	25.0	12	27.3	11	25.0	7	15.9	9	20.4	2	4.5	2	4.5	20	45.6
Indirect and direct—Rec	—	—	1	20.0	—	—	1	8.3	3	33.3	—	—	—	—	—	—	1	4.7
Sliding—444	—	—	13	59.0	3	13.6	8	36.3	3	13.6	2	15.3	4	30.6	2	15.3	10	45.4
Sliding—Rec	—	—	—	—	—	—	—	—	—	—	1	33.3	—	—	—	—	1	9.9
Total—444	22	3.4	199	30.9	82	12.1	194	30.2	142	20.1	69	10.2	42	6.2	13	1.9	221	33.7
Total—Rec	2	8.3	16	7.4	5	5.7	15	7.1	12	7.8	5	6.7	8	16.0	2	13.3	20	8.3

153 repaired with chromic, the incidence of recurrences being a 2.16 and 9.8 per cent, respectively. The greatest difference is noted in the sliding hernias 35 of which were repaired with silk and 12 with chromic, 6.6 per cent of the silk repairs recurring and 25 per cent of the chromic recurring. The recurrences in the recurrent hernias are comparable but slightly higher than those of the simple hernias. Glenn and McBride reported a series of 500 hernias repaired with silk with the following percentage of recurrences: 2.3 in the indirect inguinal group, 6.21 in the direct inguinal group. In 1919 Masson reported 7,016 cases of inguinal hernia repaired with 20 day chromic catgut with a less than 1 per cent recurrence in the cases with cord transplantation and slightly more than 1 per cent in the cases in which the cord was not transplanted. He does not give follow-up statistics, consequently, it is impossible to determine how many of his patients were examined at the Mayo Clinic. His figure would be more impressive if he had found this low recurrence in his followed cases.

Silk as a suture material is being more frequently used in clean surgical cases. In this series twisted A or C silk or finely woven Deknatel silk was used throughout. That catgut varies in its durability and lasting qualities has been very clearly shown by Kraissl in a report on the absorption rate of catgut. In this article he also shows that there are individuals, appearing more frequently than one would expect, who are sensitive to catgut. In these cases there is a definite reaction about the sutures and in all cases of wound disruption in allergic patients in which

catgut was used and the skin test for sensitivity made, the patients gave a positive reaction. He advocated the use of the skin test of all patients for sensitivity to catgut before using it. If this is done in cases of hernia repaired with catgut the difference in the incidence of recurrences as compared to the incidence of recurrence in those repaired with silk might be much less.

The hernias comprising the group repaired with suture materials other than those described are too few in number to warrant further discussion. There are three recurrences in the cases in which the choice of suture was not mentioned and two recurrences in the strangulated hernias.

The operations in this series can not be classified in the usual manner. Each operative note describes the repair specific to that case. It is, therefore, impossible to list the repair as a typical Bassini, Halsted, Ferguson, Wyllys Andrews or any other type. The remainder of the discussion of the inguinal hernias will be limited to the main points described in the operation notes.

The treatment of the hernial sac consisted of freeing it from the surrounding tissue. If adhesions were encountered these were severed by either blunt or sharp dissection which was carried as far as the internal ring. The sac was then excised and ligated and in many instances the stump of the sac was transfixed under the internal oblique muscle. There are no cases in which the sac was used as a tampon as advocated by MacEwen and Ferguson.

The transversalis fascia has been considered one of the first lines of defense in the repair of hernia since the days of Halsted and Ferguson. The

TABLE VI—TRANSPLANTATION OF CORD

Inguinal hernia	Cord under aponeurosis				Cord subcutaneous				Cord not transplanted				Cord not used			
	444		Rec		444		Rec		444		P c		444		P c	
	No	Per	No	Per	No	Per	No	Per	No	Per	No	Per	No	Per	No	Per
Indirect	371	64.2	16	3.5	53	12.0	9	15.0	35	8.3	1	2.7	32	1.2	4	1
Direct	0	0	2	3.7	35	79.1	6	14.0	2	1.6	—	—	13	2.8	5	19.7
Indirect and direct	17	18.6	5	1.0	12	27.3	3	7.6	3	4.3	—	—	1	15.0	—	—
Shling	3	61.9	1	7.8	6	38.2	2	34.3	—	—	—	—	2	6.3	1	33.3
Total	371	61.0	22	5.6	104	23.3	18	24.8	30	6.6	1	2.7	4	12.1	8	27.7

usefulness of this layer varies greatly with individuals. It is frequently so thin that it is of little value while in other cases it is difficult to define it as a separate layer. Anatomically it is easy to understand the importance in the treatment of this layer of tissue as it forms the first and probably the most important line of defense against recurrence. However stress should be laid on the repair of this fascia in the region of the internal ring for it is in this region that this fascia is the weakest and consequently the site of most recurrences. The triangle formed where this fascia allows the cord and its structures to emerge from the abdominal cavity should be very carefully repaired. Elsewhere one of the following three methods which will be mentioned can be used to strengthen this layer of fascia deep to the cord.

This fascia was used in 450 hernias with 32 or 7.1 per cent recurrences. It was used in one of the following methods: suture of the fascia to Poupart's ligament and plication. The effectiveness of the use of the fascia is tabulated in Table V. From this it can be seen that it did not materially lower the incidence of recurrences in those cases in which attention was paid to the transversalis fascia. In the indirect inguinal group suturing of the transversalis fascia to Poupart's ligament seemed to be most effective with only 9 or 5.5 per cent recurrence while in the direct group of hernias those in which the fascia was plicated there was only 1 or 2 per cent recurrence. It is very difficult from this series to come to any conclusion as to the value of the use of the transversalis fascia in preventing recurrences in inguinal hernias. If the operative notes had described in detail the treatment of this layer of tissue at the internal ring a more detailed and critical analysis could have been made. In this connection it is interesting to note that in the cases in which the treatment of the transversalis fascia was not mentioned there were only 19 or

6.9 per cent recurrence, a figure which is slightly lower than that in which the fascia repair was used.

In practically every instance the conjoined tendon and the lower border of the internal oblique muscle was sutured to the shelving margin of Poupart's ligament. Those cases in which the conjoined tendon was either obliterated or too narrow to make its use effective will be discussed under the living fascia sutures.

Halsted and Bassini simultaneously described transplantation of the cord as an important step in hernia repair. In Bassini's operation this was transplanted to lie immediately beneath the aponeurosis of the external oblique muscle. Halsted transplanted the cord subcutaneously in his early cases later modifying the position according as he found the pathology. Table VI gives the frequency of cord transplantation with the incidence of recurrence. In 393 hernias it was left under the external oblique and in 122 hernias it was placed superficial to this structure. Included in the instances in which it was left subcutaneously are a few cases in which it was left between the leaves of the imbricated margins of the aponeurosis as described by Bell and Andrews. Transplanting it under the external oblique was most effective in the cases of direct inguinal hernias with the recurrence of 2.7 per cent. The group of hernias in which the cord was placed to lie subcutaneously had in all but one group a higher incidence of recurrence than in the other cases when it was left under the external oblique. There are only 40 cases in which it was definitely stated that the cord was not transplanted, 35 of which were indirect inguinal hernias, 1 of which recurred. In 82 cases the treatment of the cord was not mentioned. In 2 cases the cord was treated much after the manner described by Torck (27) with separation of the vas from the veins of the cord in neither was there recurrence. Morel

good's procedure of excising the veins was performed in a few cases. This was limited to the cases in which the spermatic cord was unusually large. The treatment of the cord was not stated in most of the operative notes of the recurrent hernias. The cases in which the cord was excised with orchidectomy are listed elsewhere.

Living fascial sutures were used in 139 hernias. In 74 cases the suture was taken from the lower margin of the aponeurosis and in 50 a strip of the tensor fascia femoris was used. In 15 cases a strip of either the rectus muscle or fascia was used to strengthen the medial angle of the repair. The use of the rectus fascia was limited to those cases in which the conjoined tendon was either obliterated, narrow, or so frayed that it was of little value. Recurrences were noted in 5, or 6.7 per cent of the cases repaired with a strip of the external oblique aponeurosis, in 8, or 16 per cent of the cases repaired with fascia lata, and in 2, or 13.3 per cent of those in which the rectus muscle or fascia was used. Fascia lata was used more frequently in the cases of recurrent hernia, this may possibly explain the higher incidence of recurrence in this group. In many of the cases in which repair was done with fascial sutures and there was recurrence the operative note describes the previous fascial repair as being satisfactory.

Sliding hernia were found in 3.1 per cent of the series. This is a somewhat lower incidence than noted in other papers. The viscera found in these hernias are: cecum, 5 times, bladder, 4, and sigmoid, 9. In 2 of the cases the bladder was accidentally opened. There were 76 recurrent hernias with 11.9 per cent recurring. This figure is lower than reported in other papers.

In the group of 72 femoral hernias, 10 were strangulated, 4 recurred, and 3 patients died, 5 patients failed to return to the follow-up clinic and are omitted from this discussion. Thirty-six of the hernias were repaired through incisions made below Poupart's ligament, 18 from incisions above and paralleling the ligament, 4 so called vertical incisions, all of which probably belong to the first group, 5 combined incisions which ran from below up and lateral across the ligament, 3 rectus incisions, and in 6 cases the position of approach was not clear. Bassini's technique of suturing the pectineal fascia to Poupart's ligament was done in 37 cases. The other repairs were done as follows: in 2 cases Poupart's and Cooper's ligaments were brought together, 3 cases in which the defect was closed with a purse-string suture, 3 in which the defect was closed from within the abdomen and in 12 the method of repair was not stated in detail. Recurrence was

noted in 1 case in which repair was done by suturing Poupart's ligament and the pectineal fascia together; the 2 other recurrences in the group were in the cases in which repair was not clear. There were 10 strangulated and 30 irreducible hernias in this group, 2 of the strangulated hernias were of the Richter type.

The mortality analysis of the strangulated hernias has previously been discussed. That femoral hernias strangle more frequently than inguinal hernias is a well known fact. This was also noted in this series, there being 10 strangulated femoral hernias in 72 cases as compared to 18 strangulated hernias in the larger inguinal group. In 5 of the 28 cases the intestine had been compromised to such an extent that resection was imperative. In each case it was the small intestine which was resected. Duration of acute symptoms preceding operation varies from 3 hours to 5 days, the greatest number presenting themselves within 20 hours of onset. In those patients who died the hernia had been strangulated 24 hours or longer. The 3 patients requiring resection died, all 3 had had symptoms longer than 48 hours.

As there are only 9 cases of umbilical hernia and 10 cases of epigastric hernia only a little valuable information can be gained from their analysis and consequently they will be discussed together. There were 2 cases of umbilical hernia in the male and seven in the female, while in the epigastric group 7 were in males and 3 were in females. Only 2 of the umbilical hernias were in patients under 35 years, 4 patients were between 36 and 45 years with 1 occurring after the 45th year. The age incidence in the epigastric group is almost identical and will not be repeated. The technique of horizontal overlap as described by Mayo was used in 6 cases of umbilical hernia, the 3 others being repaired by simple approximation of the edges of the defect. Six of the epigastric hernias were also repaired by approximating the edges of the defect without an attempt at either a vertical or a horizontal overlap. Silk was used in 8 cases of epigastric hernia and only once in umbilical hernia. Chromic catgut sutures were used in 7 cases of umbilical hernia and in only one of the epigastric hernias. Kangaroo tendon was used once as well as chromic and silk. There was one infection in the umbilical group, and three of these patients were drained. All of the wounds in the epigastric hernias healed *per primam*. One of the epigastric hernias recurred.

#### SUMMARY AND CONCLUSIONS

In concluding it might be stated that the purpose of this review is to summarize our cases of

hernia and to present the incidence of recurrence and of certain factors as they were found in the cases which did not recur as well as in those which did recur. A complete metamorphosis in hernia repair took place following Bassini's and Halsted's papers describing their techniques which today are still the most satisfactory and have been changed but little since the publication of their articles.

The difference in the incidence of recurrence in all types of hernias repaired with silk as compared to those in which chromic catgut was used is very striking. Studies, which are now being made, indicate that the failure in those cases in which repair was accomplished with chromic catgut can partly be explained as being due first to a defect in the suture material, second, variability of the absorption rate, and third patient's sensitivity to catgut.

Better results were obtained in those cases in which the cord was left under the external oblique aponeurosis.

This series of cases re-emphasizes the fact that if a technique can be so elastic as to meet the variations anatomical and pathological, found in hernias the perfect hernia repair is yet to be described.

#### BIBLIOGRAPHY

1. ANDREWS EDWARD WYLLIS A plastic operation for hernia umbilicor or lap joint method. Chicago Med Rec 1895 9 67
2. BASSINI GIOVANNI Novo metodo per la cura radicale dell'ernia Inguinale Atti d Cong d Ass med ital 1887 An Iavia 1899 21 379 1883 Pavia
3. Idem Ueber die Behandlung des Leistenbruchs Arch f klin Chir 1899 40 423
4. BLOOMGOOD JOSEPH C The transplantation of the rectus muscle in certain cases of inguinal hernia in which the conjoined tendon is obliterated Johns Hopkins Hosp Bull 1908 9 90
5. BELL WILLIAM T and COLE WILLIAM D Observations upon the operative treatment of hernia at the Hospital for the Ruptured and Crippled Ann Surg 1898 28 37
6. Idem Report of 2000 operations for the radical cure of hernia performed at the Hospital for the Ruptured and Crippled from 1899 to 1907 J Am M Ass 1907 40 1017

7. DAVIS LINCOLN Complications and sequelae of the operation for inguinal hernia J Am M Ass 1916 67 480-483
8. FRIEDMAN SEWARD Inguinal hernia in the male with regard to the late operative sequelae Ann Surg 1917 66 702
9. Idem Inguinal hernia in the male (late results in 978 traced cases) Ann Surg 1923 77 171
10. FERTUSON, ALEXANDER HUGH On the radical cure of inguinal and femoral hernia by operation Am J Surg 1895 21 547
11. Idem Oblique inguinal hernia typical operation for its radical cure J Am M Ass 1899 33 6
12. Idem The technique of modern operations for hernia Chicago 1907
13. FOSTER GEORGE V The use of fascia lata in the repair of hernia Surg Gynec & Obst 1916 63 631
14. GLENN FRANK and McBRIDE ANDREW Surgical treatment of 500 hernia Am Surg 1916 104 1024
15. HALSTED WILLIAM S The radical cure of inguinal hernia Johns Hopkins Hosp Bull 1899-1900 1 17
16. Idem The radical cure of inguinal hernia in the male Am J Surg 1893 17 549
17. Idem The operative treatment of hernia Am J M Sc 1895 new series Cx 13
18. Idem The cure of the more difficult as well as the simpler inguinal hernia Johns Hopkins Hosp Bull 1903 14 65
19. JUDS EDWARD S Inguinal hernia—type of operation—end result in 1892 cases J Minn M Ass & Northwest Lancet 1908 28 65
20. KRAUSE C J Intrinsic factors altering the absorption of catgut Surg Gynec & Obst 1910 63 561
21. LUNA WILLIAM Rectus tranplantation by a special technique Ann Surg 1913 53 673
22. MASSON JAMES C Returning inguinal hernia Minn Med 1919 11 373
23. MAYO WILLIAM J Umbilical hernia Ann Surg 1901
24. Idem Further experience with the vertical overlapping for the radical cure of umbilical hernia J Am M Ass 1903 41 3
25. TAYLOR ADRIAN S The results of operations for inguinal hernia Arch Surg 1901 321
26. TURNER FRANK Combined operation for the removal of the appendix and the cure of the right inguinal hernia Am J Surg 1906 43 605
27. Idem A contribution to the study and surgical treatment of oblique inguinal hernia Med Rec 1912 81 1114

# EDITORIALS

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## CONTROLLING OPERATING ROOM STERILIZERS

IT will probably come as a surprise to some, if not to many, surgeons that today, nearly a half century since the advent of aseptic surgery, materials frequently are delivered to the operating room which, from the nature of the procedure of sterilization, could not properly be considered sterile.

A number of items enter into the reasons for this unfortunate and even dangerous situation. In the first place, there is no clearly established rule for deciding what personnel should do the sterilizing and one sees this important process carried out by persons ranging from janitors and busboys, through a changing personnel of student nurses, to experts employed to do nothing but sterilize hospital goods. Many persons who sterilize these supplies have not the slightest notion of the fundamental principles involved nor even rudimentary knowledge of the mechanical equipment used. A second reason is to be found in the equipment, not necessarily the apparatus

itself but its state of repair. One extreme case recently was noted wherein for days no steam had entered the sterilizer because of a plugging of the steam valve, the nurse not having noted the failure of the gauge to register. A third factor, and probably the most important from the practical standpoint, is failure to appreciate the obvious fact that the pressure gauge is a safety device to help prevent explosion and that the important factor so far as sterilization is concerned is temperature. In this connection few seem to know that a mixture of steam and air reduces the temperature without affecting the pressure and that only in the presence of pure steam is the proper pressure-temperature ratio maintained. To obtain an atmosphere of pure steam requires thorough exhaustion of the chamber and this directs attention to a fourth reason for lack of sterilization; namely, that manufacturers frequently have not provided adequate means of exhausting the air and condensed steam from the inner chamber. The by-passes are frequently small and easily plugged with debris or lime. Far better is it to open the door and let the steam flow freely into the room at the beginning than to fail to exhaust the chamber at the end. The use of a vacuum is begging trouble for this tends to suck in air through any small leak. It is far better to exhaust air by steam pressure than by air vacuum. A fifth factor is found in the practice of overloading the sterilizer with materials, especially in tightly packed packages. This precludes the ready access of steam to the materials and causes great variation in the time-temperature ratio in individual packages, making it necessary to exceed the required time for running the sterilizer in order to assure sterilization. It must



he constantly remembered that the penetration of steam into packages varies with the nature of the material, their positions in the chamber, and the tightness with which they are packed.

The important point is to be sure that each piece of material has been submitted to adequate temperature for an adequate time. Unfortunately there is no universal agreement on this matter. How short a time may be considered acceptable to some may be seen from recent specifications submitted by one bureau calling for devices which will indicate "sterilization" at 250 degrees F. for not less than 5 minutes and not more than 6 in a light surgical pack. While it is questionable if this is enough time even for test tube experiments, it clearly gives no margin of safety, which certainly should be at least thrice the time required and some would advocate more. While the exact time-temperature relationship may be considered of academic interest only, it is clear that whatever it is one should know that materials have been submitted to a predetermined temperature for a predetermined time. This can be known only by the use of some reliable indicator of which there are three types.

The first of these indicators is a recording temperature clock. This is a positive device and the bulb of the thermometer should be placed in the exhaust steam line. The instrument is expensive and troublesome and does not necessarily give the temperature of the inside of a typical package. Relatively few sterilizers are equipped with the device or are likely to be.

The second device is a glass tube in which a chemical of fixed melting point is sealed. If these tubes are tested in an oil bath the chemical melts in a few seconds at 250 degrees F. or even at lower temperatures. It is assumed by some that when these tubes are

placed in gauze packages they act as lag thermometers. The time of lag is certainly variable and under no circumstances does the chemical take longer than a few minutes to melt. If there is any margin of safety at all it is slight and, under many conditions, the chemical melts before the minimal time and temperature have been maintained. If these tubes are used, several should be employed in each load and they should be employed with full knowledge of their obvious limitations and of the expense involved.

Finally there are the ink indicators, which are fixed as to the relation of time and temperature and must be submitted to moist heat for a given time at a given temperature before a change of color occurs. One such indicator has several inks on it, which turn at five minutes, twelve and a half minutes, twenty minutes, and more than twenty five minutes, respectively. These are reliable, sharp at end point, and permit one to know the exact condition under which the sterilization has been accomplished. If one of these devices is inserted in a pack which is then placed at the coldest place in the sterilizer, one may be assured of adequate sterilization if the ink has turned. The margin of safety desired can be readily controlled. Certainly if the twenty minute ink has turned, the margin is fully adequate and the few extra minutes will not cause any great inconvenience. For rubber gloves, which have first been adequately prepared before autoclaving twelve and a half minutes is sufficient. The total length of time the sterilizer will need to be steamed varies with the particular conditions attending the procedure.

More recently an entirely new device has been invented and used. This consists of a time clock which will not permit the door of the sterilizer to be unlocked until a certain temperature has been maintained for a cer-

tain length of time The expense and intricacy of the device, the fact that it is marketed at present by only one firm, and will not routinely test the condition of individual packs, will naturally limit its use.

What is urgently needed is for some responsible body to set up standards for these sterilizer controls, for there is much difference of opinion now as to the necessary time-temperature ratio Whatever ratio is agreed on it should carry with it a margin of safety adequate to cover all the usual slips in technique. The indicator should be required to have a controllable lag time, a sharp end point, and to be stable, easily used, and cheap It will be desirable to have to use only one indicator to the load. No better standardizing body could be suggested than the American College of Surgeons and the importance of the matter would justify its attention to this problem

T B MAGATH

## THE ENDOMETRIAL BIOPSY

IT is interesting that the term "biopsy" has come to mean to some a method of obtaining tissue for examination. It is essential that the term be understood to refer to the diagnostic (usually microscopic) examination of a piece of tissue removed from a living subject Examination of the tissue and the information thus gained are, of course, the significant features. The term has nothing to do with the method employed to obtain tissue nor with the type of instrument used When the term "endometrial biopsy" is used herein, therefore, it implies that the tissue may be obtained either by diagnostic dilatation and curettage or by means of any instrument with which satisfactory endometrial specimens can be obtained Since the information gained by the proper examination and interpretation of endometrial findings is one of the features

requisite for the intelligent management of menstrual dysfunctions, it seems justifiable to restate briefly some of the helpful steps in this procedure

It becomes increasingly evident that far more information can be obtained from such a diagnostic procedure than mere exclusion of a malignant process which in itself is, of course, important Until the last few years, however, in that large group of cases in which no malignant change was encountered, the tendency was prevalent to label all of these non-malignant tissues as hypertrophied or hyperplastic endometrium. It is known now, however, that the microscopic appearance of the endometrium holds the information so essential to the proper interpretation of ovarian function regardless of whether the function is normal or abnormal. Endometrial biopsy has limitations, however, in that it fails to give the information necessary to allow the dysfunctions to be classified on a basis of etiology This merely means that the reflection of the ovarian disturbance in the endometrium is the same, regardless of whether the cause of the ovarian disturbance comes from within the ovary (primary ovarian deficiency) or whether the cause of the disturbance in the ovary is secondary to disturbed physiologic function of the pituitary or thyroid glands which so definitely control ovarian activity (secondary ovarian deficiency) Endometrial biopsy, however, has proved to be the greatest single aid in determining whether the ovarian deficiency is partial or complete.

It is known, not only from clinical observation but also from the brilliant experimental studies of those concerned with these problems, that the regenerative phenomena which occur monthly in the endometrium are controlled by the action of the normal output of the estrogenic principle, a product of the follicle, and that the differentiation of this

tissue into a functioning unit is directly dependent on the action of the product of the corpus luteum, progesterone. The recovery of progesterone from urine of women was delayed for a considerable period. The explanation of this lies in the fact that the product of the corpus luteum, unlike the product of the follicle (estrogen), is excreted as a changed compound to which has been given the name pregnandiol. To Venning and her associates is credited this excellent observation which has recently been confirmed by Wilson, Randall, and Osterberg. Before isolation of this product it was possible, however, by observation of the endometrial histologic characteristics, to predict the almost exact time of appearance in the urine of this recently isolated material. The prediction, of course, was made by observing the changes in the histologic pattern of the endometrium which follow almost immediately the period of initial activity of the corpus luteum.

Endometrium is the only human tissue in which study of regeneration has been possible. Regeneration of endometrium, just as is true of regeneration of any tissue, follows a definite histologic course of events. From observations of this process have come the interpretation of abnormal ovarian activity in terms of what normally occurs in regeneration. The first half of the regenerative process (menstrual cycle) consists in active proliferation of the tissue and this proliferation is controlled entirely by the action of estrogen, the product of the normally functioning follicle. As has been stated, differentiation of the endometrium into a functioning tissue depends on the principle of the corpus luteum, progesterone. It follows then that irregularity in the functional balance of the ovarian hormones which control this process is followed by irregularity in the regenerative phenomena controlled by these hormones. This in turn results in men-

strual dysfunction either bleeding, amenorrhea or sterility. If, therefore, the intention is to learn something concerning the activity of these hormones on the endometrium, tissue for study never should be obtained, either by instruments designed for office purposes or by dilatation and curettage, until the normal period of activity of these hormones on the endometrium has passed. For example, the information desired from examination of this tissue will not be obtained if specimens are removed from the uterus in the first half of the menstrual cycle (proliferative phase) regardless of whether the cycle is normal or abnormal. Normally, regenerative phenomena will have reached completion about twenty-five days after onset of the last period of bleeding. If, therefore, a disturbance of the regenerative process, as manifested by a persistently proliferative type of endometrium, is found on the twenty-fifth day, when differentiation should be nearly complete, then the desired information has been obtained, namely, that there has been a failure of luteinization. Specimens for study therefore, always should be taken around the twenty-fifth day of the cycle, regardless of whether the cycle is considered normal or abnormal, that is, the specimen should be removed twenty-five or more days after onset of the last period of bleeding.

Another significant feature of the problem lies in the fact that often, in examination of removed tissue, a study mistakenly is made of the basal layers of the endometrium. This will not afford information of value since the basal layers remain the same throughout the cycle. Therefore, the section of tissue studied always should contain the surface epithelium for it is from this portion of the tissue that the regenerative process is carried on. If the procedures mentioned are followed, often it is possible to determine the clinical syndromes associated with certain endometrial patterns. For exam-

ple, Randall and Herrell recently reviewed 278 cases of ovarian dysfunction in which cystic changes occurred in the endometrium. Classifying these tissues on the basis of the regenerative phases mentioned, they found that the greater the tendency toward differentiation, which is a function of the corpus luteum, the smaller the tendency toward bleeding dysfunction, while the tendency is greatest toward sterility. On the other hand, when these cystic changes were associated with arrestment of the regenerative process in the proliferative phase of the cycle (corpus luteum deficiency), the tendency was greatest toward bleeding dysfunction and to a lesser degree toward sterility.

It is further interesting that study of this remarkable regenerating tissue has recently led to the observation that cancer of the endometrium nearly always is associated with a certain type of endometrial pattern, namely, a persistently proliferative type of endometrium which denotes the presence of the estrogenic principle but lack of the differentiating power of the luteinizing factor. Absence of any evidence of malignancy in the endometria of patients previously subjected to oophorectomy is somewhat startling. These observations seem pertinent in view of the growing evidence for the carcinogenic tendency for estrin and estrin-like preparations

WALLACE E. HERRELL



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the authors point out in favor of the operation of jejunoplasty for this complication of what may seem to be a perfectly performed anastomosis or resection can be appreciated easily. They believe that this procedure should reverse the mortality rate following this complication because it relieves the obstruction at the actual point of occurrence with the minimum amount of surgery and, at the same time, permits direct inspection of the gastric stoma.

**G**YNECOLOGISTS and obstetricians may derive pleasure in entering the old controversy over whether or not a *myomectomy* or a *hysterectomy* should be done when fibroids complicate pregnancy and the fetus is viable. HUBER, formerly of Chicago, now of Indianapolis, evaluates the merits of each procedure and outlines in detail the management that he advises after consideration of all the problems concerned. Likewise, you may be interested in the fact that Professor ZONDEK, for various reasons, which he explains, is now performing myomectomy even more frequently than was his custom in the past. His experiences and indications are enumerated in a very interesting fashion.

**I**N the past the Editors have subscribed to the commonly held theory that all students of medicine welcome the opportunity to study the life, work, and environment of the great contributors to their profession, particularly if these are offered in an attractive and easily readable form. Our experience has confirmed that belief.

Recently we have brought reproductions of fine engravings of well known portraits of outstanding

men in medicine to our readers. This effort has been based on the conception that a fine gallery of art would serve better if it were mobile, that is, if its fine works of art could be placed on exhibition at intervals in every larger city in the country. We have, as a matter of fact, tried to do more than this. Each of these reproductions can be removed from the Journal and framed or preserved in any manner our readers choose.

We intend to add to the group already published an engraving by Henry Cousins of an Andrew Morton painting of SAMUEL COOPER. The senior surgeon to the North London Hospital, Cooper was the Samuel Johnson of medical literature. Though of a different stamp, and written with a different object, his *Dictionary* was to surgery what Johnson's great work was to English literature.

Sir Thomas Lawrence was a great artist and a Turner engraving of his magnificent portrait of Sir HENRY HALFORD, we think will please you. Physician to four successive sovereigns of England—George III, George IV, William IV, and Queen Victoria—he may be the one who long ago expressed the reason for the present interest of the laity in the life of doctors, when he said: "The conduct of a physician on whom is fixed the only hope of saving life, and on whom the dying look often rests, before the eye is closed forever, may fairly be thought interesting to every hearer."

The Editors hope that you will find these subjects which are to be discussed in forthcoming issues of SURGERY, GYNECOLOGY AND OBSTETRICS interesting and that these beautiful portraits will afford you pleasure.

# ACROSS THE EDITORIAL DESK

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IT is given to few surgeons to enunciate *principles of surgical treatment* but Philibert Joseph Roux who spent the active years of his surgical life in the Hotel Dieu in Paris where he lived from 1780-1854, stated such a principle which has become a law. In substance he said that functional pressure permits the formation of bony callus but tension or shearing forces inhibit the formation of callus and stimulate the production of fibrous connective tissue. Almost 100 years later, Pauwel described the reclinant method of the physiological reconstruction of non united fractures of the neck of the femur and his idea is based entirely upon the law enunciated by this same Roux. KARFOL of San Francisco uses Pauwel's method and describes the advantages not found in other procedures. Of course there are few subjects about which there is so much discussion and in the treatment of which there are so many different methods as fractures of the neck of the femur.

PERHAPS you will not be in agreement with Karfol's conclusions and prefer one of the many other methods in common usage. For example LEXNIG, of St. Louis, discusses the *treatment of fractures of the neck of the femur* and gives the results following the use of the Smith Peterson nail in a group of 75 patients treated during 1937.

SURGEONS of an older generation learned from many bitter experiences with children suffering from diphtheria just how to perform a tracheotomy but the introduction of antitoxin and the decrease in the number of cases of diphtheria have made the emergency operation of tracheotomy a rare one. Many of the younger generation of surgeons have probably never seen the operation, much less performed it. Mr. CANTHOVE of London describes in detail just how to perform the unhurried, planned operation of tracheotomy so that the surgeon may well be acquainted with the procedure when circumstances demand a hurried operation.

THE moot question of just how much thyroid gland should be removed in a patient with hyperthyroidism is one which must be judged by every surgeon interested in *thyroid surgery*. CATTELL and PERLIN of the Lahey Clinic present

evidence which suggests that the pre-operative blood iodine level may be used as an index to determine the amount of gland tissue to be removed. Thus, an attempt is made to remove the question from one of personal judgment and place it upon a more scientific factual basis.

THE popularization of the use of *continuous suction applied to the indwelling duodenal tube* by Wangenstein and his associates at the University of Minnesota has led to rather widespread discussion of how long is required for dechlorination to do harm incident to the aspiration of the gastroduodenal secretions, how much fluid and what kind of fluid should be given and how the loss of fluid and sodium chloride can be estimated quickly and practically. PAINE from the surgical department of the University of Minnesota discusses this question and suggests two practical clinical methods for the quantitative estimation of the chlorides in the urine.

SURGEONS, gynecologists, and obstetricians are all interested in any suggestion that makes *blood transfusion* simple, efficient and rapid. Some institutions have found the answer in the employment of a transfusion team. Others use blood banks. Professor A. HUSTIN and Dr. A. DUMONT, of Brussels describe a method which they use in transfusing citrated blood. Perhaps the reader will like his own method much better but he may get some suggestions for improvement from Professor Hustin's article.

THERE have been many modifications of the basic operation for gastrostomy and perhaps each surgeon has evolved his own method and technique, but we believe that our readers will be interested in the well illustrated method for an *aseptic double valved tubogastronomy* described by GLASSMAN and based upon work done in the anatomical and surgical departments of the University of Illinois. This should be particularly interesting to the younger surgeon who may not have had a considerable experience with the operation of gastrostomy. This is also true of the beautifully illustrated article by HOAG and SAUNDERS which describes a jejunoplasty for the relief of obstruction following gastro-enterostomy or subtotal resection of the stomach. The advantages which

The postgraduate student will find a ready and helpful guide to the problems of otology and the undergraduate and the general practitioner will find a useful consultant and aid to diagnosis and treatment of diseases of the ear

Twenty-six chapters and over four hundred pages with fifty illustrations comprise the text

JOHN F DELPRÉ

THE *Outline of Roentgen Diagnosis*<sup>1</sup> represents a revision and expansion of the lecture notes used by the author in the teaching of roentgenology. As the title indicates and as the author states in the preface, this book is not a reference work but rather a synopsis of a very extensive subject. It goes without saying that it would be impossible to discuss and illustrate in detail the many uncommon conditions or to elaborate upon the rarer manifestations of the common diseases in a text of this type. The subject matter is dealt with in an orderly and concise manner and is a tribute to the author's experience in teaching. The indications, possibilities, and limitations of a roentgen study in each disease process are stressed throughout the text.

The book has been made up in two formats. One includes a pictorial atlas of 254 illustrations and reproductions of roentgenograms while in the other, suitable for teaching, the atlas section has been omitted. Although the atlas appears at the end of the volume, there are numerous references and cross references in the text to this section. The reproductions of roentgenograms are excellent and wisely chosen. Line drawings are utilized rather extensively and in most instances illustrate the lesion very well, but in others it would seem that reproductions might have been used to better advantage. This is not, however, a major fault. In illustrating many lesions the author has very wisely used line drawings rather than roentgenograms which often fail to reproduce well enough to demonstrate clearly the lesion under consideration. The unique drawings by Jean E. Hirsch illustrating the diseases of bones and joints are worthy of note. All illustrations are reproduced in the negative.

The subject matter has been divided into the following sections: general principles of roentgen diagnosis, bones and joints, diseases of the spine and spinal cord, skull and its contents, thorax, digestive tract, gall bladder, abdomen, urinary tract, female generative organs, and miscellaneous. All of the common disease processes falling under these various headings are adequately discussed.

This volume should be of interest to teachers of roentgenology. The author's orderly and concise manner of presenting the whole subject makes the book ideal for class room work and as a text for graduate students. It is recommended to members of the medical profession as a valuable addition to their library.

EARL E. BARTH

<sup>1</sup>OUTLINE OF ROENTGEN DIAGNOSIS. AN ORIENTATION IN THE BASIC PRINCIPLES OF DIAGNOSIS BY THE ROENTGEN METHOD. By Leo G. Rikler, B.S., M.D. Atlas and student editions. Philadelphia, London, Montreal and New York. J. B. Lippincott Co., 1938.

THE third edition of *A Textbook of Gynecology*<sup>2</sup> by Arthur Hale Curtis, contains eight new chapters on anatomy, physiology, and the endocrine glands, which were not discussed formally in the two previous editions. The subject matter has been entirely rewritten and is based on the author's own experience combined with carefully selected excerpts from the current literature.

The chapter on anatomy is exceedingly timely because it is presented from the gynecologic standpoint and represents new and original work in dissection of the cadaver as well as in the operating room, coupled with Dr. Curtis' wide experience in this field. The drawings are unique in that they are original and made from dissections.

The discussion of organotherapy is excellent. The author's statement that "the average clinician is endocrine conscious and has endocrine panic," is very apt. Without camouflage, he presents the various gynecological disorders, which, in the past few years, have been treated with good, bad, and indifferent results, and he indicates clearly the few ailments successfully handled at the present time with the various preparations now available.

Descriptions of the more common gynecological operative procedures are included and they are clear, thorough and well chosen, as well as, accompanied by unusually fine illustrations. The importance of pre-operative and postoperative care is stressed and the management of various complications included. The indications and contra-indications for radiotherapy are ably discussed and the use of sulfanilamide in various pelvic disorders is described.

This is a book of 603 pages and 318 illustrations; it covers in a concise, direct manner the whole field of gynecology, and for this reason is ideal for the student and general practitioner, it also is a valuable addition to the gynecologist's library.

JAMES C. MASSON

THE English translation of *The Vitamins and Their Clinical Application*,<sup>3</sup> published in Germany the early part of 1936, was made in the early part of 1938. The manual is an informative résumé of the history of vitamins and the progress made in vitamin science during the few years previous to 1936.

A historical introduction is presented on each of the known vitamins. There then follows discussions on the chemistry (giving chemical formulas), determination, occurrence, manifestation of the vitamin deficiency, and the daily requirements in man. Attention is called to some of the reliable commercial preparations, with dosage, that may be used in treating vitamin deficiencies. The last three chapters are discussions on vitamins and human nutrition, daily vitamin requirements for man, and the antagonism of vitamins and its importance in vitamin therapy.

<sup>2</sup>A TEXTBOOK OF GYNECOLOGY. By Arthur Hale Curtis, M.D. 3d ed. Philadelphia and London. W. B. Saunders Co., 1938.

<sup>3</sup>THE VITAMINS AND THEIR CLINICAL APPLICATION. By Prof. Dr. W. Stepp, Doz. Dr. Kuehnau, and Dr. H. Schroeder. Translated by Herman A. H. Bouman, M.D. Milwaukee, Wis. The Vitamin Products Co., 1938.



# THE SURGEON'S LIBRARY

## REVIEWS OF NEW BOOKS

THE authors of *Surface and Radiological Anatomy*<sup>1</sup> have commendably ventured to move beyond the customarily accepted range of treatises on surface anatomy. To the established methods of physical examination they have added those of radiology thus a dependable old method is modernized and vitalized by the addition of a new.

Illustrations are bountifully used through their excellent character, the authors have succeeded in coordinating radiographic anatomy with those external bodily features discoverable by sight and touch and these in turn with the details of deeper morphology with which the reader has become familiar in the dissection laboratory. Pictorially the student and the practitioner is furnished with a superb record of human structure accruing from three branches of anatomic science by means of which he is enabled to view the body as if it were a transparency transfer to its external regions the sites of osseous visceral vascular and nervous elements.

Each part of the human body is treated on a systematic plan. To select an example the superficial muscles of the extremities are discussed as palpable structures in relation to surface outlines these relations being rendered graphic by the employment of parallel illustrations their margins are described in reference to bony prominences to losses produced by their elevations, and to deeper structures discoverable by palpation the important contents of the fossae are in turn described as to position and course within the space. The discussion then proceeds to movements possible at the particular joint the movement of individual bones being illustrated by photographs of a living subject upon which the outlines of the bones have been projected radiographs presented in serial order illustrate the changing interrelationship of bones which compose the joint.

In the chapters on the thorax and the abdomen the reader is carried successively through a discussion of surface landmarks of parietal musculature and of contained viscera.

There is an uncommonly good discussion of the principles of radiological examination supplemented by drawings to illustrate the special significance and anatomy of oblique views. Where radiography may profitably be supplemented by direct examination of the living organ gastroscopy cystoscopy, et

cetera are added to the authors abundant list of features.

During the years in which the reviewer has employed radiography as an adjunct to the regular course in dissection the need for such a textbook has been constantly felt. Altogether, this is a remarkable work. So inclusive is the content so logical the arrangement of subject matter that it may safely be recommended to the medical student in any period of his training and to the practitioner.

BARRY ANSON

AN extremely well compiled review of the literature in regard to sulfanilamide therapy of bacterial infections is presented by Mellon Gross and Cooper.<sup>2</sup> The early history of the drugs is of special interest from the standpoint of a therapeutic applicability of the azo compounds.

There are chapters on the pharmacology chemistry and chemotherapeutic effects of sulfanilamide. In these chapters the authors have very thoroughly reviewed the literature including all of the important references in regard to the experimental uses of the drug. The chapters on the experiments *in vitro* and *in vivo* should be read by anybody who is using sulfanilamide compounds. Other high points of interest are the effects reported in infections other than the streptococcus group namely meningitis gonococcus and pneumococcus infections.

The reviewer would certainly like to commend the authors for compilation of so much valuable data concerning a drug of which so little is generally known. This book at least begins to fill a large gap in our knowledge of chemotherapy.

GILBERT H. MARQUARDT

THE book *Practical Otology*<sup>3</sup> by Dr. Levine is written from thirty years experience of teaching graduate students and is essentially a compilation of a series of lectures given during that period. It is not a textbook in the usual sense as all controversial subjects and long drawn out descriptions are left out the author devotes himself to short concise descriptions of the subject matter.

The book has been entirely overhauled and re-written with new chapters on the latest work on petrositis and aviators ear. There is a valuable formulary accompanying each chapter on treatment.

SULFANILAMIDE THERAPY OF BACTERIAL INFECTIONS WITH SPECIAL REFERENCE TO DISEASE CAUSE BY HEMOLYTIC STREPTOCOCCI, PNEUMOCOCCI, MENINGOCOCCI AND GONOCOCCI. By Ralph K. Mellon Gross M.D. Dr. P.H.D.S. (H. I. Pa.) Gross M.D. a d Fra. k. B. Coopers M.D. Springfield Ill. a d N. Y. more M.D. Ch. des C. Th. m. 1935  
PRACTICAL OTOLARYNGOLOGY. By Morris A. Levine M.D. F.I.C.S. 2d rev. ed. Philadelphia L. & F. B. 1935

SURFACE AND RADIOLOGICAL ANATOMY. FOR STUDENTS AND GENERAL PRACTITIONERS. By Arthur B. Appleton M.A. M.D. (Camb.) Will. m. J. Hamlin, M.D. B.Ch. (B. N.), D.Sc. (Gl. s.) F.R.S.E. a d Ivan C. C. Tch. pe. off. M.A. M.D. B.Ch. (Camb.) D.M. R.E. Baltimore Will. m. Wood & Co. 1933



This manual offers a clear presentation of the subject of vitamins and their practical application to the human being both in health and disease. However the reader must bear in mind the many new discoveries that have been made in vitamin science during

the past 3 years. The vitamin chart with detailed bibliography (found in the appendix) offered by the English editors is valuable for those who desire to make a special study of the vitamins. References on this chart are only up to 1937. C. J. BAKROGA

## BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

**CLINICAL ELECTROSURGERY.** By Gustavus M. Blech. GCS, GCG, MD, LL.D. With chapters by Hector Alfred Colwell, MB, PhD, DPH, LRCP, MRCS, and Brian Wellington Windeyer, FRCS, D.M.R.E. London, New York, Toronto: Oxford University Press, 1938.

**ORTHOPEDIC APPLIANCES: THE PRINCIPLES AND PRACTICE OF BRACE CONSTRUCTION FOR THE USE OF ORTHOPEDIC SURGEONS AND BRACEMAKERS.** By Henry H. Jordan, MD. Foreword by E. G. Brackett, MD. New York, London, Toronto: Oxford University Press, 1939.

**THE OBLIQUELY CONTRACTED PELVIS CONTAINING ALSO AN APPENDIX OF THE MOST IMPORTANT DEFECTS OF THE FEMALE PELVIS.** By Dr. Franz Carl Naegele, Mainz. Victor von Zabern, 1830. Centennial Edition. Newly Translated from the Original German by Alfred M. Hellman, MD, FACS, and George Musa, MD. New York, 1939.

**ANATOMIE CHIRURGICALE DU CRÂNE ET DE L'ENCÉPHALE.** Published under the direction of André Latarjet. By Charles Clavel and Michel Latarjet. Paris: G. Doin & Cie, 1938.

**ANATOMIE ET HISTOLOGIE DE L'APPAREIL URINAIRE ET DE L'APPAREIL GÉNITAL DE L'HOMME.** By A. Hovelacque and Jean Turchini. Paris: G. Doin & Cie, 1938.

**SURGICAL TECHNIQUE AND PRINCIPLES OF OPERATIVE SURGERY.** By A. V. Partipilo, MD, FACS, 3d ed. Chicago: Chicago Post Graduate School of Surgery, 1938.

**THE ABNORMAL IN OBSTETRICS.** By Sir Comyns Berkeley, MA, MC, MD (Cantab), FRCP (Lond), FRCS (Eng), MMSA (Hon.), FCOG. Victor Bonney, MS, MD, BSc (Lond), FRCS (Eng), FRACS (Hon), MRCP (Lond), and Douglas MacLeod, MS, MB (Lond), FRCS (Eng), FRCI (Lond), MCOG. Baltimore: William Wood & Co., 1938.

**CONSULTATION ROOM.** By Frederic Loomis, MD. New York: Alfred A. Knopf, 1939.

**TRANSACTIONS OF THE FIFTY-NINTH MEETING OF THE AMERICAN SURGICAL ASSOCIATION.** Vol. 56. Edited by Walter Estell Lee, MD. Philadelphia: J. B. Lippincott Co., 1938.

**THE TREATMENT OF FRACTURES.** By Charles Locke Scudder, AB, PhD, MD, FACS, 11th rev. ed. Philadelphia and London: W. B. Saunders Co., 1938.

**TEXTBOOK OF NEURO-ANATOMY AND THE SENSE ORGANS.** By O. Larzell, PhD. New York and London: D. Appleton-Century Co., Inc., 1939.

**TRAUMA AND INTERNAL DISEASE: A BASIS FOR MEDICAL AND LEGAL EVALUATION OF THE ETIOLOGY, PATHOLOGY, CLINICAL PROCESSES FOLLOWING INJURY.** By Frank W. Spicer, AB, MD, FACS. Philadelphia, London: Montreal: J. B. Lippincott Co., 1939.

**SURGERY OF THE EAR.** Edited by Samuel J. Kopetzky, MD, FACS. New York and Edinburgh: Thomas Nelson & Sons, 1938.

# SURGERY

## GYNECOLOGY AND OBSTETRICS

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### HERNIATION THROUGH THE DIAPHRAGM

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**H**ERNIATION through the diaphragm occurs more frequently than is generally recognized by physicians. If the practitioner will suspect it as a cause for unexplained epigastric or lower thoracic complaints, and if he will follow up by the proper examinations, he will be gratified by the number of diagnoses to his credit.

In its development from the septum transversum and its accession of sternal, costal, and lumbar musculature, the diaphragm offers many opportunities for imperfect fusion of these elements. Thus, there may be abnormal openings through it from a failure in appearance, in timing, or in the fusion of the separate components. This is likely to take place peripherally in the posterolateral areas between the costal and lumbar regions, leaving the Bochdalek's foramina, or in the parasternal region, the so called foramina of Morgagni (the *fente de Larrey* of the French writers). Added to this is the fact that the stomach also forms in the thoracic region and has to descend, rotate, and assume its adult position, all in proper timing relationship to the formation of the diaphragm. In consequence, there may be complete failure of the stomach to get below the diaphragm (the thoracic stomach), or partial descent with varying degrees of

thoracic and abdominal gastric portions, or small remnants of the cardiac end of the stomach may be nipped off near the esophageal hiatus, or there may be simply an imperfectly formed area near the esophagus, a potentially weak spot which may determine the site of a future herniation if given the proper conditions.

#### TYPES OF HERNIAS

In the literature, herniations through the diaphragm are classified as true or false, depending on the presence or absence of a hernial sac. They are also considered to be congenital, traumatic, or acquired. Any of these latter groups may or may not have a true sac present. The classification is mainly one of convenience. It would be equally proper to consider some of these protrusions through the diaphragm as due to faulty fusion of the muscles, absence of portions of the diaphragm, imperfect descent of the stomach, or in case of trauma, internal eviscerations through the diaphragm.

*I. Congenital* In the etiology of the congenital hernias, the trouble usually can be traced to the imperfect development of some portions of the diaphragm, or to the improper descent of the stomach and esophagus through the diaphragm. The congenital herniations may give symptoms immediately after birth. In such a case, there is cyanosis, dyspnea, and embarrassment of the circulation. Certain positions make the condition worse while

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days later of bronchopneumonia, myocarditis, prostatic hypertrophy, hydro-ureter and hydronephrosis

Congenital herniations through the parasternal area may give precordial pain, a feeling of tightness in the chest, retrosternal pressure, or palpitation. Strangulation of the bowel with its accompanying symptoms has occurred in 10 per cent of the reported cases of retrosternal diaphragmatic hernia (12)

CASE 7 E M, No 47362, a male, aged 22 years, was admitted to Strong Memorial Hospital on May 10, 1931. As long as he could remember he had had a constant, dull pain in the left chest medial to nipple and low, this grew worse with exercise and on deep inspiration. He traced his trouble to an injury received 8 years previously. He had fallen down stairs with a bicycle, the pedal puncturing the left abdominal wall, but the peritoneum was not opened. Examination showed the left side of lower chest to be slightly more prominent than the right, and a circular scar on the left epigastrium. Otherwise he was normal. The roentgenogram showed the transverse colon through the diaphragm (Figs 5 and 6). Operation was performed with a left phrenic block. There was a well-formed sac with the transverse colon adherent, which was dissected free and the diaphragm closed. The patient is now well.

The diagnosis of congenital herniation through the diaphragm is exceedingly difficult to make at times. The symptoms caused by these hernias have been detailed in the preceding paragraphs. The signs given by herniated viscera into the thoracic cavity are variable and difficult to evaluate. The combinations of air, fluid and solid material produce many peculiar signs. The congenital and traumatic types are likely to confuse the physician, as there are usually more contents in the thoracic cage in these varieties.

In the last analysis, the diagnosis is possible only by accurate roentgenograms which show the position of the organs in relation to the diaphragm. It may be necessary to give barium by mouth to outline the organs involved accurately. When the large bowel is in the herniation, a barium enema will demonstrate the portion of the colon which is participating.

The prognosis depends upon the size of the opening through the diaphragm and the character of the herniated viscera. When the vital capacity is much reduced, the infant may not survive the early days. As he becomes more



Fig 1 Case 3 This is the usual picture of a herniation of the small and large intestine through the left posterolateral Bochdalek's foramen

accommodated to the compression of the lungs he may compensate for it by expansion of the opposite side. The pressure on the mediastinum may cause a considerable shift of its contents. In theory it is possible that the heart and great vessels may be embarrassed by the abnormal mechanical pressure. When once the infant passes the early critical period, he may not show any evidence of trouble except perhaps in general underdevelopment and in distortion of the thoracic cage. These have been noted frequently by keen clinical observers. There is always the danger of potential obstruction and strangulation, although in my experience this is far less frequent than has been reported by others. Strangulations in herniations through the foramen of Morgagni have been reported in 10 per cent of cases (12).

The treatment depends upon the type of the lesion and the nature of the symptoms it produces. The congenital types should probably be operated upon at a favorable time when possible, and under stress conditions when necessary. The most common postero-

others relieve it. There may be alarming and critical attacks alleviated only by administration of oxygen. These patients may require surgery although the risk is very great.

**CASE 1.** D. C., No. 96068, a female, was admitted to Strong Memorial Hospital December 1, 1934 at 5:30 p.m. At 6:00 a.m. December 2 she gave birth to a male infant after a normal delivery. The child was very cyanotic at birth but was resuscitated. Three attacks of extreme cyanosis and dyspnea occurred during the day. Breath sounds were very faint over the left chest where there was slight fullness anteriorly and laterally; there was cardiac dullness anteriorly on the right, the point of maximum impulse was in the fourth right intercostal space. The roentgenogram showed herniation through the diaphragm. When on the left side, cyanosis was less but several attacks necessitated the use of the oxygen tent. An exploration was performed on December 6 but it was impossible to return the organs from the chest by either the thoracic or the abdominal route. An oxygen tent was employed after operation but the infant died on December 8, 1934.

#### Some infants do not survive the first day

**CASE 2.** B. B., No. 83262, a boy baby who died soon after birth. At postmortem examination a large opening was found posteriorly through the left diaphragm. The stomach, the small intestine and all of the large intestine down to the descending colon occupied the left thoracic cage. The mediastinum was shifted to the right. There was coarctation of the aorta and dilatation of the ductus arteriosus.

Other patients may adjust themselves to the changed relationships and be considered normal. Only later in life it may be noted that they are below the average development for their age and that an abnormality in the shape of the thorax exists. Such patients may present no symptoms referable to their herniation.

**CASE 3.** H. S., No. 87308, a boy aged 12 years in good health till September 14, 1933 was admitted to Strong Memorial Hospital on September 21, 1933 because of a respiratory infection followed by diabetes mellitus. Previous history revealed pneumonia at 2 years. Examination showed prominence of the anterior chest wall, region xiphoid dullness on percussion on left side from angle scapula to base for ward to anterior axillary line, signs of fluid diminished breath sounds and vocal fremitus. Diagnosis showed resolving pneumonia thickened pleura and pleural effusion. Roentgenographic diagnosis revealed consolidation or pleural effusion. Gurgling sounds heard suggested bowel invagination. A gastro-intestinal series showed herniation of the large and small bowel through the diaphragm (Fig. 1).

There may be very trivial upsets in digestion.

**CASE 4.** R. F., No. 10751, a boy aged 5 years was admitted to Strong Memorial Hospital January 6, 1933. There had been irregular vomiting for 2 years usually at night but no other complaint. Temperature was normal, pulse 100, respirations 20, white blood cells 6,000. The left thorax was more prominent than the right, in the left lung from mid scapula to base, vocal fremitus was decreased and percussion note flat but there were no rales. Heart sounds were heard best to the right, no shift of heart was made out. There were prominent veins over the upper abdomen, and numerous walnut sized masses on both sides of the abdomen. Various diagnoses of pleural effusion, untorsioned pneumonia, tuberculosis, lung abscess and bronchiectasis were considered by attending physicians (Fig. 2). Signs and symptoms did not fit any of these diagnoses. The possibility of hernia was finally suggested and a gastro-intestinal series made the diagnosis sure. Operation was performed and the organs were restored to the abdominal cavity. The posterior defect in the diaphragm is demonstrated in Figure 3. The wound was packed to form adhesions and the result was good.

Some patients may go through life with very few complaints (Cases 5 and 6).

**CASE 5.** C. F., No. 106886, a man aged 61 years, was admitted to Rochester Municipal Hospital on September 14, 1935 with a fractured left hip. Examination showed the patient to be semicomatose, the entire chest full of rales, complete fracture of the left femoral neck, arteriosclerosis and auricular fibrillation. He died in 4 hours. Postmortem examination revealed bronchopneumonia, pulmonary fat embolism, cirrhosis of the liver and other signs of degeneration due to age. In addition the right diaphragm showed a bulging into the right cavity behind a band of fibrous tissue which extended from the spine to the anterolateral chest wall. This diaphragmatic herniation contained the right lobe of the liver and lateral to it some small bowel loop.

**CASE 6.** A. H., No. 40178, a male aged 70 years was admitted to Strong Memorial Hospital on October 19, 1930. He had intermittent pain in the epigastrium for 1 year, a loss in weight of 30 pounds, icterus, emaciation, hypertension, bladder retention, benign prostatic hypertrophy, cystitis, fever, white blood cell 18,000 to 32,000 and anemia. A gastro-intestinal series showed a mass in the pyloric region, and herniation of the transverse colon through the diaphragm (Fig. 4). Under scopolamine and local anesthesia the abdomen was explored. Chronic cholelithiasis, cirrhosis and chronic pancreatitis were found and a cholecystoduodenostomy was performed. The patient died 14



Fig 5 Case 7 Herniation of transverse colon through left parasternal defect (Morgagni's foramen)



Fig 6 Case 7 Lateral view indicating the constriction of the bowel at the sac opening

known by acute dilatation of the abnormally situated organs. If not relieved relatively soon, it may lead to strangulation.

**CASE 8** R C, No 114648, a male, aged 32 years, was admitted to the Strong Memorial Hospital on May 4, 1936. In an auto accident 3 days previously he suffered a fracture of the left ilium, right clavicle, and herniation of the stomach through the left diaphragm. The left chest lagged on inspiration. Percussion note was tympanitic anteriorly from the third left interspace to the ninth left interspace, there were also splashing and gurgling sounds. There were no breath sounds, vocal fremitus was decreased, there was an absence of tactile fremitus, and the heart was displaced to the right. The electrocardiogram showed auriculoventricular heart block and myocardial damage, Wassermann reaction was 4 plus. Operation was performed with a phrenic nerve block and the rent in the diaphragm was repaired. The tear was to the right of the esophageal hiatus. The cardia and the pylorus were side by side at the level of the diaphragm. Omentum and splenic flexure were drawn up into the chest. It was necessary to enlarge the rent to free the organs. The stomach was markedly dilated. Exposure was obtained by a costoplastic procedure. A stormy convalescence followed, but the patient was discharged in good condition on August 10, 1936 (Fig 7).

In other accidents the herniation symptoms are completely submerged. It may be months or years before the condition is suspected or

makes itself known. There may then follow symptoms referable to the occlusion of the viscera which have herniated through the tear in the diaphragm. There will also be a gradual compression of the lung on the involved side with a diminution in the vital capacity. In Case 9 this amounted to 28 per cent. The heart is slowly displaced toward the opposite side of the chest by pressure on the mediastinum. This may lead to cardiac disturbance by angulation and distortion of its vascular connections.

**CASE 9** F M, No 113380, a woman, aged 33 years, was admitted to Strong Memorial Hospital on May 18, 1936. She was in an auto accident August 29, 1935, and suffered a fracture of 6 ribs on the left side. She remained in the hospital 1 month and another month with relatives. On her return home, she suffered pain in the back, shortness of breath, and sharp pain while eating. A roentgenogram revealed herniation of the stomach, transverse colon, splenic flexure into the chest, and a heart displaced to the right. Examination showed angulation of the second to the eighth ribs on the left, posteriorly, percussion note was dull with moderate tympany over the left thorax, laterally and posteriorly, and





Fig 2 Case 4 A roentgenogram such as this is quite confusing for interpretation

lateral variety through the foramen of Bochdalek can be approached either by the thoracic or abdominal route or a combination of the two. A lateral thoracic incision between the



Fig 4 Case 6 Bilateral herniation through the paraesophageal foramina (Morgagni)

ninth and tenth ribs will usually expose the defect and allow easy closure by removal of an overlying rib, if necessary, for relaxation. This is not so easily done from the abdominal side. The parasternal types should have a preliminary phrenic block and closure from the abdominal route. In those unusual congenital herniations through the central tendinous area or in the paraesophageal region, the operations to be described for the traumatic and acquired types should be successful.

**2 Traumatic** Traumatic herniations through the diaphragm are the results of tears through the muscular or tendinous portions with the escape of abdominal viscera into the thorax, aided and abetted by the differences of pressure between these two cavities. The trauma necessary to cause a tear in the diaphragm almost always represents a severe injury of some kind to the lower thorax or upper abdomen. Such injuries occur from anything which causes violent doubling or torsion of the body such as auto accidents, falls, machinery accidents, gunshot wounds, stab wounds, or heavy lifting. Traumatic herniation has occurred at childbirth, or from the rupture of an abscess through the diaphragm from either side—a subphrenic abscess or empyema.

Often times the symptoms of traumatic herniations are masked by the shock incident to the severe accompanying trauma. In some instances however the condition makes itself

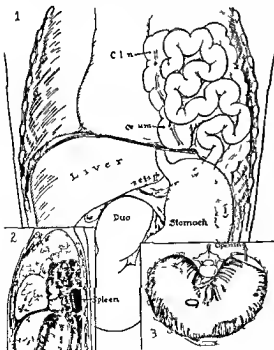


Fig 3 This drawing represents the defects in the diaphragm and the position of the organs in the thoracic cavity in Case 4



Fig 9 Case 9 The large intestine has also herniated into the thorax

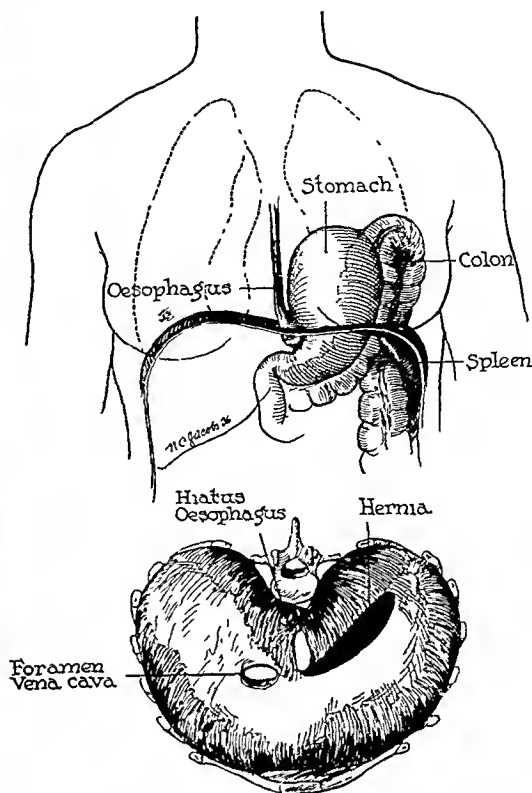


Fig 10 Drawing showing the traumatic defect in the diaphragm and the condition found at operation in Case 9

such as gastritis, gastric ulcer, gastric cancer, pylorospasm, duodenal ulcer, cholecystitis, and cholelithiasis, or the symptoms may be difficult to differentiate from esophageal conditions such as cardiospasm, diverticulum, benign stricture, or carcinoma of the esophagus; or finally, there is a chance to confuse these symptoms with those of some cardiac conditions such as angina pectoris, coronary occlusion, and myocardial damage. The gastro-intestinal symptoms include epigastric pain, and distress or fullness, which may or may not be relieved by soda, food, rest, belching, vomiting, or change of position. Some patients complain of this pain especially after large meals, or shortly after retiring at night. Sometimes the pain is accentuated by deep breathing or by leaning over; and often it is relieved by assuming the erect posture. The pain frequently radiates to the angle of the scapula. Belching and gas on the stomach, nausea and vomiting are relatively common. The presence of blood in the vomitus or stool, accompanied by dizziness, weakness, and severe anemia, often lead to suspicion of a

bleeding ulcer. These patients occasionally have upsets in their bowel habits, diarrhea or constipation. They often develop fear of eating and in consequence may lose weight. This causes the physician to consider a diagnosis of cancer. The esophageal symptoms include the following: difficulty in swallowing, increasing inability to retain food, regurgitation, a feeling of pressure in the retrosternal region, and loss of weight and strength. The cardio-respiratory symptoms are heart pain and palpitation, substernal pain and pressure, radiation of pain to the arms, shortness of breath, and fear of impending death. Diaphragmatic spasm sometimes causes phrenic pain and hiccoughs.

As more of the stomach becomes involved in the herniation, the symptoms may intensify, become more frequent and are not relieved easily. When incarceration and fixation occur, the symptoms may become continuous de-



Fig. 7 Case 8. Traumatic rupture of the left dome of the diaphragm. The stomach has herniated into the left thoracic cavity. It is obstructed and operation is imperative. Catheter shows in much dilated stomach.



Fig. 8 Case 9. Traumatic rupture of the left diaphragm. Gastro-intestinal series shows herniation of stomach into left thoracic cavity.

breath sounds were distant. An operation was performed by means of a phrenic block. The stomach and colon were restored to the peritoneal cavity and the torn diaphragm was repaired. Convalescence was uneventful. There has been no trouble since operation. Vital capacity before operation was 2.6 liters, after operation 3.75 liters. Total capacity before operation was 3.50 liters, after operation 5.25 liters. The vital capacity was reduced 28 per cent. Carbon dioxide and oxygen of the arterial blood before operation were normal. The dyspnea was due to reduced vital capacity and pulmonary reserve (Figs 8, 9, 10).

Herniations of the traumatic type can be handled from the thoracic or from the abdominal approach. Surgeons who do a great deal of thoracic surgery usually prefer the thoracic operation. The claim is made that it is easier to work from the upper side of a tear with everything below you than it is to work on the under side with everything above. Others choose the abdominal operation as it is easier in their hands. There should be no quarrel regarding the relative merits of these methods. The well equipped surgeon should be prepared to operate by either or both approaches if necessary. The tear in the central

tendon should be freshened and approximated accurately. Temporary paralysis of the diaphragm by phrenic nerve crush may be of assistance although it is not always a necessity. If the approach is through the thorax this can be carried out or not as needed.

3. *Acquired.* Hernias of the acquired type more nearly correspond to hernias of other portions of the abdominal cavity. These acquired diaphragmatic hernias develop at areas of weakness. They often require years in their formation. An unusual strain may quickly accentuate them. They are fostered by upward pressure of the intra abdominal viscera, by aspiration and the vacuum suction power of the thoracic cavity, by a traction cone caused by esophageal muscular contraction, and by the insinuation of fat tabs which act as entering wedges to dilate the small openings. Their para esophageal situation is quite characteristic.

The symptoms of the acquired esophageal hiatus are the most interesting. These herniations give symptoms which may closely mimic those of gastro intestinal conditions



Fig 9 Case 9 The large intestine has also herniated into the thorax

such as gastritis, gastric ulcer, gastric cancer, pylorospasm, duodenal ulcer, cholecystitis, and cholelithiasis, or the symptoms may be difficult to differentiate from esophageal conditions such as cardiospasm, diverticulum, benign stricture, or carcinoma of the esophagus; or finally, there is a chance to confuse these symptoms with those of some cardiac conditions such as angina pectoris, coronary occlusion, and myocardial damage. The gastro-intestinal symptoms include epigastric pain, and distress or fullness, which may or may not be relieved by soda, food, rest, belching, vomiting, or change of position. Some patients complain of this pain especially after large meals, or shortly after retiring at night. Sometimes the pain is accentuated by deep breathing or by leaning over, and often it is relieved by assuming the erect posture. The pain frequently radiates to the angle of the scapula. Belching and gas on the stomach, nausea and vomiting are relatively common. The presence of blood in the vomitus or stool, accompanied by dizziness, weakness, and severe anemia, often lead to suspicion of a

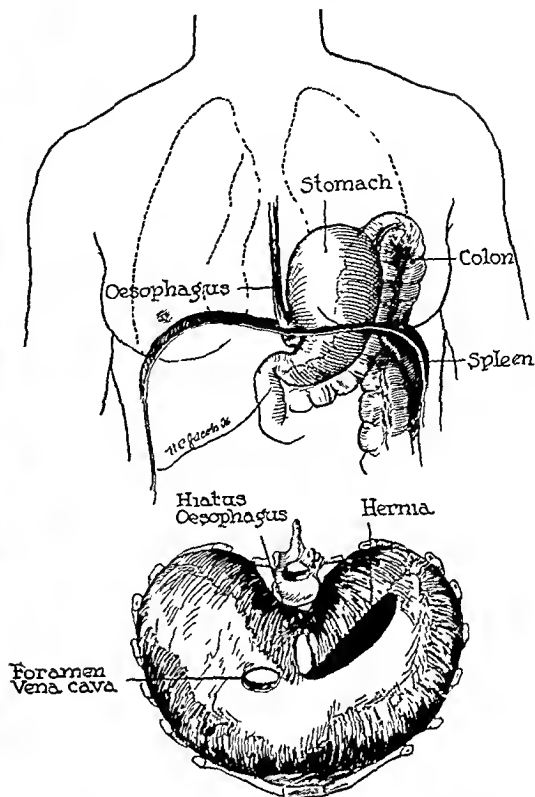


Fig 10 Drawing showing the traumatic defect in the diaphragm and the condition found at operation in Case 9

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Fig 11 Case 13 Herniation of a portion of the fundus through the para esophageal hiatus. There is associated esophagospasm as shown by the string like lower esophagus. This area relaxed at times and filled normally.



Fig 12 Case 14 A large amount of the fundus has herniated through the diaphragm at the para-esophageal hiatus. The ruga can be seen traversing the constricting ring of the sac.

manding surgical intervention for relief. The bleeding is a sign of significance, indicating congestion or thrombosis of vessels about the constricting ring of the opening with erosion of the mucous membrane and even ulceration in a number of cases.

Many patients go through their lives with only minor trouble, easily controlled by medical treatment. But when the symptoms become continuous and intense, surgery must be seriously considered.

The following case histories illustrate the variation in the symptomatology in esophageal hiatus herniations. Cases 10 and 11 demonstrate the gastro intestinal symptomatology.

CASE 10 C C, No 105474 a woman aged 47 years was admitted for the fourth time to Strong Memorial Hospital on June 21 1937. Previous admissions were for acute gastro enteritis suspected gastro intestinal malignancy secondary anemia and achlorhydria. Hernia through the diaphragm at the esophageal hiatus finally was demonstrated. In 1926 a laparotomy was performed because a diseased gall bladder was suspected. This was not found and it was thought that a duodenal ulcer was present. Posterior gastro enterostomy was done at that time. Epigastric hunger pain 3 hours after eating is now relieved by food and soda. Lower thoracic pain is relieved by recumbency. She obtained relief under medical treatment. She gave this up and during 5 months all symptoms grew worse with dyspnea hypochromic anemia and achlorhydria and she became sallow. The patient improved under medical treatment.

CASE 11 L F, No 122726 a male aged 72 years was admitted to Rochester Municipal Hospital on December 21 1936. Nine months previously he suddenly lost his appetite because eating caused sub sternal pain which radiated to both lower quadrants. There were associated nausea and vomiting. Roentgenograms at that time were reported as cancer of the lower esophagus or cardiac end of the stomach. There was a loss of 10 pounds in weight and anemia. Examination showed the patient to be emaciated pallid with an enlarged prostate and secondary anemia. The gastro intestinal series revealed diaphragmatic hernia with cardiospasm, doubtful lesion at the cardiac end of the stomach. There was achlorhydria but there was no blood in the gastric secretion. The general opinion of consultants was against carcinoma. The patient was discharged for medical care.

Case 12 illustrates the difficulty in differentiating one of these hernias from a cardiac condition.

CASE 12 No 119025 a male aged 48 years was admitted to Strong Memorial Hospital on September 8 1936. He had had a pressure sensation in the chest for 5 years which he thought to be dyspepsia. For 1 year he suffered with palpitation and dyspnea which he relieved by cutting down on cigarettes 30 a day. Three weeks previous to admission he experienced a severe sensation of pressure in the chest with sharp pains in both arms. He felt as if chest and arms were gripped in a vise and this lasted 6 minutes. He suffered a similar attack the same evening. In Boston the electrocardiogram was interpreted as coronary disease. The patient was put on heart drugs. Examination showed a heart slightly enlarged with some extra systoles. The electrocardiogram showed extra ventricular systoles and a sino auricular block. The gastro intestinal series revealed that the fundus slid laterally and



Fig. 13. Case 15. Large herniation with marked symptoms. Fluid retention and fluid level well demonstrated. Diaphragm shadows show through breast shadows.

anteriorly through a defect in the diaphragm on deep inspiration. The patient was discharged to his physician. Repeated attacks of discomfort after meals were found to be associated more with the hernia. He can now take strenuous exercise with a regular heart. The patient is quiescent under medical treatment but if trouble recurs surgery is to be performed.

Cases 10, 11, and 12 showed large herniations of the cardiac end of the stomach through the esophageal hiatus similar to that in Figure 20. In Case 13 the esophageal symptoms were in the foreground.

CASE 13. E.B., No. 115330, a woman, aged 74 years, was admitted to Strong Memorial Hospital on May 22, 1936. For 2 to 3 years food had stuck in her throat and would not go down especially solid food and cold drinks. She could swallow hot drinks. Her distress increased food went to a point in the center of breast bone stopped and hurt quite badly. She suffered shortness of breath, belched and regurgitated. She could usually raise a mouthful of slime in the morning. For many years the patient suffered with gas on stomach and belching but no pain and no heart burn. She was afraid to eat and had lost 10 to 15 pounds in 5 months. Examination showed her to be alert, well nourished, and normal for her age. The impression was cardiospasm, but the gastro-intestinal series revealed herniation, a part of the stomach was through the diaphragm and there was an angulation of the esophagus. Symptoms continued but the patient wanted nothing done. Phrenic nerve crush has been advised (Fig. 11).

The 3 following cases are examples of incarceration and fixation in the hernial sac. Surgery is advisable in these cases to get relief. The patients are so uncomfortable that they accept operation readily.

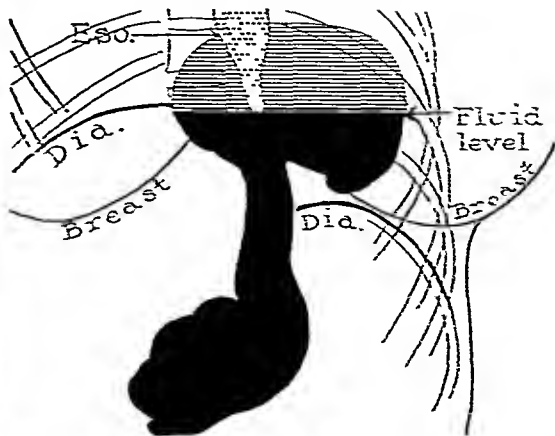


Fig. 14. Case 16. Tracing of roentgenogram showing large portion of stomach herniated through para-esophageal opening. Esophagus demonstrated to be of normal length. Operation possible.

CASE 12. E.B., No. 58015, a woman, aged 39 years, was admitted to Strong Memorial Hospital on July 6, 1932. She began to have attacks of sharp pain in the lower left chest 12 years previously but the cause was undetermined. The patient showed signs of hematemesis 1 year before. Gastric ulcer was diagnosed and strict diet gave no relief. The pains grew worse and during the last 5 weeks she had endured frequent and severe epigastric pain. For 1 week there had been constant pain, slight fever, hiccoughs and very troublesome pain radiating down the inner side of the left arm. Dyspnea had been present on exertion for 8 years. Examination showed the patient to be well developed and nourished; the general physical examination was normal. The gastro-intestinal series revealed a large herniation of the stomach through the diaphragm. She was operated upon and the herniation admitted 3 fingers easily. The spleen, adherent to the sac, was torn in freeing it. Severe bleeding followed which was controlled by suturing the spleen. The herniation was packed after partial closure. There was some shock and a slow recovery. Since operation the patient has gained 20 pounds in weight, and there is only an occasional mild discomfort in the left, upper quadrant. She has developed arthritis of moderate severity (Fig. 12).

CASE 15. M.E., No. 74010, a female, aged 53 years, was admitted to Strong Memorial Hospital on April 13, 1933. One and one half years previous to admission she began to have epigastric pain, burning in character, radiating to left upper quadrant 1 to 2 hours after eating. It was relieved by soda and vomiting. She experienced freedom from pain for 1 to 2 week periods. Two weeks before admission, respiratory infection associated with epigastric pain, nausea and vomiting were present. Examination revealed an enlarged heart and hyper-



FIG 11 Case 13 Herniation of a portion of the fundus through the para esophageal hiatus. There is associated esophagospasm as shown by the string-like lower esophagus. This area relaxed at times and filled normally.

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**CASE 10** C. C. No 105474 a woman aged 47 years was admitted for the fourth time to Strong Memorial Hospital on June 21 1937. Previous admissions were for acute gastro enteritis suspected gastro intestinal malignancy secondary anemia and achlorhydria. Hernia through the diaphragm at the esophageal hiatus finally was demonstrated. In 1926 a laparotomy was performed because a diseased gall bladder was suspected. This was not found and it was thought that a duodenal ulcer was present. Posterior gastro enterostomy was done at that time. Epigastric hunger pain, 3 hours after eating is now relieved by food and soda. Lower thoracic pain is relieved by recumbency. She obtained relief under medical treatment. She gave this up and during 5 months all symptoms grew worse with dyspnea hypochromic anemia and achlorhydria and she became sallow. The patient improved under medical treatment.



FIG 12 Case 14 A large amount of the fundus has herniated through the diaphragm at the para-esophageal hiatus. The ruga can be seen traversing the constricting edge of the sac.

**CASE 11** L. F. No 122726 a male aged 72 years was admitted to Rochester Municipal Hospital on December 27 1936. Nine months previously he suddenly lost his appetite because eating caused sub sternal pain which radiated to both lower quadrants. There were associated nausea and vomiting. Roent genograms at that time were reported as cancer of the lower esophagus or cardiac end of the stomach. There was a loss of 20 pounds in weight and anemia. Examination showed the patient to be emaciated pallid with an enlarged prostate, and secondary anemia. The gastro intestinal series revealed diaphragmatic hernia with cardiospasm, doubtful lesion at the cardiac end of the stomach. There was achlor hydria but there was no blood in the gastric secretion. The general opinion of consultants was against carcinoma. The patient was discharged for medical care.

Case 12 illustrates the difficulty in differentiating one of these hernias from a cardiac condition.

**CASE 12** No 119025 a male aged 48 years was admitted to Strong Memorial Hospital on September 8 1936. He had had a pressure sensation in the chest for 5 years which he thought to be dyspepsia. For 1 year he suffered with palpitation and dyspnea which he relieved by cutting down on cigarettes 30 a day. Three weeks previous to admission he experienced a severe sensation of pressure in the chest with sharp pains in both arms. He felt as if chest and arms were gripped in a vise and this lasted 6 minutes. He suffered a similar attack the same evening. In Boston the electrocardiogram was interpreted as coronary disease. The patient was put on heart drugs. Examination showed a heart slightly enlarged with some extra systoles. The electrocardiogram showed extra ventricular systoles and a sino-aortic block. The gastro intestinal series revealed that the fundus slid laterally and



Fig 17 Case 48 The constricted area of the herniated portion of the stomach is well shown The fluid level shown in Figure 16 is in a subdiaphragmatic diverticulum of the greater curvature of the stomach

are a good many cases in which only a small knuckle of the fundus is demonstrated during the gastro-intestinal barium study (Fig 18) The 15 following cases serve to illustrate this type of patient The symptoms are often severe although the herniation is small In some cases the herniation undoubtedly was responsible for most of the symptoms, in some cases there were other pathological lesions associated, in some, the demonstration of the hernia was apparently only coincidental

Cases 18, 19, 20, 21, 22, 23, and 24 have a predominant gastro-intestinal history

CASE 18 L C, No 109266, a male, aged 80 years, was admitted to Strong Memorial Hospital on November 17, 1935 The patient gave a history of epigastric pain, belching, cramps with nausea and vomiting for 5 to 6 years Five days previous to admission diarrhea, melena, and pain occurred Examination revealed pallor, slight enlargement of the heart, umbilical hernia, liver 2 fingers breadth down, enlarged prostate, hypertension and arthritis His red blood cells were reduced to 125 red blood cells, hemoglobin 4.5 grams The patient was drowsy but there was a gradual improvement The gastro-in-



Fig 18 Case 49 Some small herniations can be demonstrated in the flat plate as extensions of the gas bubble above the diaphragm

testinal series revealed a small diaphragmatic hernia, 2 duodenal ulcers He had spells of bleeding Final improvement was brought about under medication

CASE 19 E McK, No 121043, a female, aged 70 years, was admitted to Strong Memorial Hospital on November 5, 1936 There had been insidious onset of general weakness, anorexia, and insomnia 6 months previously from which the patient recovered somewhat with bed rest Similar attacks occurred 2 months later with vague epigastric discomfort especially on bending over There was present

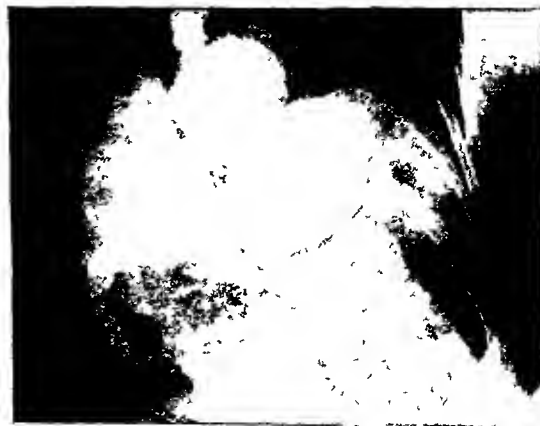


Fig 19 Case 50 A lateral view sometimes gives an accurate picture of the amount of herniated stomach and its relation to the diaphragm





Fig 15 Case 39 This roentgenogram shows a large herniation. Many of the cases have herniations of this size.



Fig 16 Case 43 The roentgenogram shows the herniation of the stomach through the diaphragm. It resembles a cystic area in the lower left thorax. A fluid level is seen below the diaphragm on the left.

tension. The gastro intestinal series showed a large herniation of the stomach through the diaphragm. An operation was performed in which stomach and spleen were returned to the abdominal cavity. There was no ulceration of the stomach and the diaphragm was repaired. Convalescence was uneventful. The patient has been asymptomatic to 1938 (Fig 13).

CASE 16 FS No 3725 a woman aged 64 years was admitted to Strong Memorial Hospital on November 3, 1926. Anemia and weakness occurred periodically for 14 years and the onset always followed fatigue. She had been in bed all summer previous to admission. Iron and rest usually were all that were necessary. There was no loss in weight and no gastro intestinal symptoms. Severe melena occurred 27 years before and there was occasional bleeding from the rectum since. Examination showed a stout, pale but generally normal individual with severe secondary anemia. Tarry stools were noted. The gastric secretion had a normal acidity but blood was present. The gastro intestinal series revealed a large portion of the stomach above the diaphragm with a definite constriction which divided the stomach into 2 portions. Her brother also had a diaphragmatic hernia. Exploration was advised and this was done by Dr Dan Jones in Boston. Her herniation was found present without constriction or

thickening of the stomach. Nothing else abnormal was found (Fig 14).

Occasionally, in spite of the severity of the symptoms, operation will be refused. In such an event treatment must of necessity be symptomatic and is not likely to be effective.

CASE 17 E B, No 58626, a female aged 69 years, was admitted to Rochester Municipal Hospital on March 21, 1932 because of abdominal pain and vomiting. The patient had been in good health till December, 1931. Then lower abdominal pain occurred with severe cramps, diarrhea, 10 to 15 stools daily, vomiting for 1 month, burning epigastric pain and belching for 2 weeks. Examination showed the patient to be well developed and nourished with adentia, thoracic kyphosis, emphysematous chest, arteriosclerosis, tenderness in both upper quadrants especially the right and a palpable mass in the right upper quadrant. Vomitus contained blood. The gastro intestinal series revealed a large herniation of the stomach 6 by 8 centimeters through the diaphragm. Surgery was advised but was refused. Vomiting continued and there was no improvement on discharge from the hospital.

The majority of patients with esophageal hiatus hernias have puzzling histories. There



Fig 23



Fig 24

Figs 23, 24 and 25 Case 54 These 3 roentgenograms demonstrate a thoracic stomach In Figures 23 and 24, 2 pouches are seen In Figure 23 the lower thorax is occupied by an air and fluid containing cystic area with an extension of a similar area to the left and below the left diaphragm The right diaphragm is above the stomach The esophageal opening is to the right of the median line and high up The whole stomach is between the right diaphragm and above the liver in Figure 25 This must be a freely mobile stomach which passes back and forth through a large defect posteriorly between the right and left leaves of the diaphragm The right diaphragm represents a true eventration There is a congenital shortening of the esophagus



Fig 25

CASE 23 W O, No 101098, a male, aged 62 years, was admitted to Rochester Municipal Hospital on April 7, 1935, suffering from vomiting, dizziness and weakness He vomited coffee ground material immediately after waking on the morning of admission This was followed by nausea and extreme weakness but no pain He had lost 35 pounds in 6 months He experienced occasional heart burn which was relieved by soda He was a heavy drinker, obese, pale, and slightly anemic with tarry stools The gastro-intestinal series showed a small diaphragmatic hernia A Sippy diet and rest were prescribed Stools were guaiac positive for 18 days, and he was discharged in good condition

CASE 24 A H, No 120834, a woman, aged 63 years, was admitted to Strong Memorial Hospital on October 23, 1936 Her complaints were heart trouble, stomach trouble and weakness, dropped beats, low blood pressure, poor appetite, frequent nausea and belching for 2 years The gastro-intes-

tinal series 2 years before were pronounced all right at another hospital She had been in bed most of the time since, had eaten little and had vomiting spells 2 weeks previously The general examination was



Fig. 20 Case 51. Herniations as large as this may not give any evidence of their presence when the patient is standing. Recumbency is necessary to show them.

some nausea but no vomiting. The patient was depressed but well developed and nourished. Her teeth were in poor condition and there was a moderate hypertension. Otherwise her condition was normal. The gastro intestinal series showed a small herniation through the esophageal hiatus, a small stomach but no ulcers. No symptoms were present while the patient was under medical treatment.

CASE 20. D. C. No. 122879, a male aged 47 years, was admitted to Strong Memorial Hospital on January 3, 1937. He complained of nervous exhaustion, headaches, weakness and a constant desire to rest for a period of 7 years. Two months previous to admission he experienced discomfort after eating which was not relieved by milk but was always relieved by soda. He also complained of constipa-



Fig. 22 Case 53. Entire cardiac portion of stomach above diaphragm. Narrow constriction at orifice.



Fig. 24 Case 57. A large portion of the stomach herniates into the thorax in some cases.

tion and had lost 5 to 10 pounds in weight. The patient was poorly developed and nourished with slight exophthalmos and hypotension. Examination was generally negative. The gastro intestinal series showed a small herniation through the diaphragm at the cardia. The patient complained of pain on inspiration as the herniation occurred. He was discharged for medical treatment.

CASE 21. R. S. No. 84491, a male aged 36 years, was admitted to Strong Memorial Hospital on December 2, 1937. For 5 years the patient had suffered distress before meals which was relieved by soda or food. His case was diagnosed as duodenal ulcer here in 1934. When he followed medical instruction he was free from symptoms. In the last few months he complained of heart burn and vomiting. On the night preceding admission he vomited blood for the first time and his stool was black. Examination showed a normal individual except for a pyloric sinus and the presence of blood in stools. There was no anemia. The gastro intestinal series revealed a small esophageal hiatus hernia which improved rapidly under medication.

CASE 22. No. 127312, a female aged 54 years, was admitted to Strong Memorial Hospital on May 2, 1936. An appendectomy had been performed 3 years previously. The gall bladder was under suspicion at that time as a source of mild epigastric distress. The patient suffered for 1 year with gas immediately after eating which was relieved by belching. There was an increasing discomfort with a sense of crowding below the sternum and occasional precordial pain. Four nights before admission a severe bout of precordial pain radiated down the left arm lasting 1 hour and requiring morphine. An oral cholecystogram was normal 3 years previously but her physician believed the gall bladder to be the base of her trouble. She was well developed. The gastro intestinal series revealed a small herniation through the esophageal hiatus, pyloric spasm and cardiospasm. There was no duodenal ulcer.



Fig 27 Case 56 Practically the whole stomach is above the diaphragm in this case (Three-fourths lateral view)



Fig 28 Case 56 The diaphragm level shows well below the thoracic stomach in this view.

of the kidneys also. In the course of his examination a small diaphragmatic hernia was noted at the esophageal hiatus. He died at home the next month.

CASE 31. R B, No. 25287, a male, aged 61 years, was admitted on May 25, 1930, to Rochester Municipal Hospital, with an impermeable stricture of the urethra. Mineral oil could be passed by the sphincter with little difficulty. Dilatation of stricture following mineral oil led to oil embolism of the lungs and kidneys. The patient died. On postmortem examination a diaphragmatic hernia was found on the left side.

CASE 32. F M O, No. 99222, a man, aged 72 years, was admitted to Strong Memorial Hospital on February 13, 1935, with a prostatic obstruction. Two weeks previously there were anorexia, fullness in the epigastrium, gradual onset of nausea following ingestion of food, and constipation. Examination showed a heart slightly enlarged to the left and moderate sclerosis. General examination was normal. The gastro-intestinal series showed a small diaphragmatic hernia. A perineal prostatectomy was performed. He was discharged in good condition and has had no further stomach complaint.

It is not uncommon to note that the whole fundus has herniated through the esophageal hiatus. Cases 33 to 36 are typical examples.

CASE 33. M S, No. 72433, a man, aged 56 years, was admitted to Rochester Municipal Hospital on May 6, 1937. For 3 to 4 months he had a chronic cough with yellowish sputum, which became bloody

in the last 4 days. There were vague anterior chest pains, some night sweats and questionable loss in weight, mild nausea and occasional vomiting. Examination showed the patient to be obese with chronic bronchitis, bronchiectasis, and chronic sinusitis. The gastro-intestinal series revealed a diaphragmatic hernia which consisted of the whole fundus of the stomach. He was discharged for medical treatment.

CASE 34. M N, No. 60770, a woman, aged 50 years, was admitted 8 times to Rochester Municipal Hospital from May 9, 1932 to October 26, 1937, for gynecological complaints, hypertension, and diabetes. On her sixth admission, February 1937, she complained of diarrhea associated with epigastric pain. This came immediately after eating and lasted 2 to 3 hours, leaving a soreness in the epigastrium. Food aggravated the pain. The gastro-intestinal series showed a large sac of stomach herniated through the diaphragm at the esophageal hiatus and associated pylorospasm. On her last 2 hospital admissions, she complained of no symptoms referable to the epigastrium.

CASE 35. A P, No. 63663, a woman, aged 63 years, was admitted to Strong Memorial Hospital on June 5, 1936. Six weeks previously she noticed mucus and blood in her stools, also a dull aching in the left, lower quadrant. There had been gas on the stomach and belching but no other gastric symptoms. Examination showed a well developed and nourished individual with arteriosclerosis and mild arteriosclerotic heart disease. Blood was present in the stool. Barium enema was negative, stomach



Fig. 16 Case 53. Spiral twist of stomach which is all above the diaphragm except pyloric end. Multiple pancreatic calculi demonstrated below the stomach confirmed at necropsy.

negative. She had lost 11 pounds in 2 months. The gastro intestinal series showed a small hiatus hernia with a duodenal ulcer suspected. Under medication the patient improved.

#### Case 25 simulates a cardiac complaint

CASE 25 J. D., No. 19024, a man aged 69 years was admitted to Rochester Municipal Hospital on September 8, 1937. On 2 previous admissions coronary occlusion and heart disease were proved by the electrocardiogram. Sharp retrosternal pain radiated to the fingers on the left side after exertion. Heart medication was given and there was a gradual recovery. There are now recurrent pains plus distention, nausea after eating, mild anorexia with a loss of 7 pounds in weight. The gastro intestinal series showed a herniation through the middle of the dome of the diaphragm when patient was in Trendelenburg position. The patient complained of pain on deep inspiration and said that this pain was what he ordinarily experienced.

Case 26 illustrates how symptoms may be latent for years in these cases, and then become annoying.

CASE 26 A. P. No. 126460 a man aged 87 years was admitted to Rochester Municipal Hospital on April 16, 1937. He had been well till 6 months previously. Then a non productive cough, shortness of breath, sensation that there was something that caused difficulty in swallowing, hoarseness and loss of weight occurred. Examination showed signs of

age and a hypertrophied prostate. Barium showed an esophageal hiatus hernia. On smooth diet and belladonna the patient improved and was discharged for medical care.

Cases 27 to 32 had other associated diseases and small thumb sized para esophageal hernia tions.

CASE 27 G. T. No. 61193 a woman aged 41 years had been admitted 15 times to Rochester Municipal Hospital from May 14, 1932 to February 9, 1937. Previous entries were for tertiary syphilis, suspected cholecystitis, right hydronephrosis, double left ureter, pyelitis, cystitis, gynecological complaints, anxiety state, etc. Careful studies failed to reveal a definite organic basis for her numerous complaints. In 1 of her later admissions she complained of nausea, vomiting, and pain in the epigastrium after meals. The gastro intestinal series showed a small herniation through the esophageal hiatus on deep inspiration. There was also cardiospasm and slight pylorospasm but no ulcer. She was maladjusted, threatened suicide and the social problem was very complicated. She was symptomatically relieved by medication. She was told about her stomach and has had relapses of her symptoms from time to time.

CASE 28 M. O., No. 39464 a woman aged 77 years was admitted to Strong Memorial Hospital on November 16, 1936. Eighteen months previously there had been an onset of pain in the right shoulder generalized later over the back which lasted 4 weeks. This was followed by a persistent non radiating pain over the entire lower abdomen without nausea or vomiting. Her mother died of carcinoma of the breast and her son had carcinoma of the colon. An appendectomy was performed 10 years previously and a gall bladder operation 27 years before. The patient was obese, with degenerative arthritis and hypertension. The remainder of the examination was normal. The gastro intestinal series showed a small herniation through the esophageal hiatus, diverticula of the duodenum and gastric and duodenal ulcers. She was asymptomatic during medical treatment.

CASE 29 E. S. No. 121036 a male aged 61 years was admitted to Strong Memorial Hospital on November 4, 1936 suffering with loss of strength and a sore tongue. For 6 weeks there had been puffiness of eyelids, palpitation of heart and pain radiating down the left arm. This was relieved by rest. He had typhoid at 16 years of age and had a yellowish appearance. When given liver and iron he improved. Diagnosis revealed pernicious anemia. The gastro intestinal series showed a small diaphragmatic hernia at the esophageal hiatus and pylorospasm. He improved under medical care.

CASE 30 A. C. No. 111371 a male aged 73 years was admitted to Rochester Municipal Hospital on January 24, 1936 with generalized tuberculosis, pulmonary, intestinal and peritoneal and probably

rate diagnosis becomes increasingly difficult. In our esophageal hiatus hernias we have noted the presence of the degenerative disease of age (arteriosclerosis, heart, kidney, diabetic, and prostatic conditions), pneumonia, syphilis, cholecystitis, gastric ulcer, cancer of the rectum and colon, and acute appendicitis.

The 4 following cases illustrate these difficulties. The patients all had very serious pathological conditions in addition to the herniation of the fundus. In all cases from Cases 33 to 43 there was as large a portion of the fundus herniated as is shown in Figure 15.

CASE 40. L G, No. 48186, a woman, aged 60 years, was admitted to Strong Memorial Hospital on January 6, 1934. She was a garrulous Irish woman who would not give a consistent story. One gathered that she had considerable pain in the lower thoracic and upper abdominal regions. It radiated under the sternum, was aggravated by eating, and relieved by hot water. There was also spasm and bleeding from the rectum. The patient also had a cough, with mucopurulent sputum. Examination showed loss of weight, hypertension, an area of dullness at the right base posteriorly with diminished breath and voice sounds, prolapse of the rectum, moderate secondary anemia and no fever. Roentgenograms showed a dense shadow on the right lung extending from the seventh posterior rib to base. The gastro-intestinal series revealed a herniation at the cardiac end of the stomach through the diaphragm. The shadow in the right chest varied in size. The patient remained in the hospital for 3 months and improved under medical treatment. Impression was that there was carcinoma of the lung and a hernia of the diaphragm. She died on May 11, 1937 at her home. The cause of death is unknown.

CASE 41. C P, No. 128726, a male, aged 46 years, was admitted to Strong Memorial Hospital on June 6, 1937. There had been a gradual onset of gnawing pain in the mid epigastrium, associated with nausea and vomiting for 4 days, vomitus was chocolate colored and blood streaked. Since then vomiting, distention and hiccoughs have continued. Temperature was 100.5, pulse 80, white blood cells, 7,300. The patient was undernourished, pale, dehydrated, and suffered loss in weight. There was a moderate distention and tenderness in the left para-umbilical region. The stool was guaiac plus, gastric analysis was also guaiac plus. The gastro-intestinal series revealed a 6 centimeters diaphragmatic hernia of the stomach with spasm of the pylorus and palisading of the small bowel. He was observed six days but there was no improvement. Exploration showed a gangrenous appendix and generalized peritonitis. Death followed 5 days after operation.

CASE 42. R T, No. 117284, a male, aged 78 years, was admitted to Rochester Municipal Hospital on July 21, 1936. The patient gave a history of occa-

sional mild substernal pain with cough, hemoptysis, night sweats, weakness, loss of weight, emaciation, and cyanosis. There were a few râles at both bases, otherwise the lungs were normal. Roentgenogram revealed a probable infiltrating carcinoma of the right lower lobe. The gastro-intestinal series showed a herniation of the fundus of the stomach through the esophageal hiatus with fixation within the thorax. The patient died in August, 1936. Autopsy showed organizing pneumonia, pyelonephritis, and general arteriosclerosis.

CASE 43. A S., No. 82548, a female, aged 57 years, was admitted to Strong Memorial Hospital on November 22, 1933. She entered because of acute urinary retention. Cystitis with a narrowing of the urethra was found. She also had a change in bowel habits, 6 to 8 months of increasing constipation and blood in the stools. Barium enema was negative, the proctoscope revealed hemorrhoids. The gastro-intestinal series showed delay and herniation of the stomach wall through the esophageal hiatus. The patient was readmitted on August 19, 1935, with increasing constipation, vomiting, pallor, and distention. Barium enema was again negative. After exploration showed carcinoma of the hepatic flexure, a cecostomy was performed. Death occurred on the following day.

The presence of syphilis in some of these patients may also render an accurate evaluation of symptoms difficult. Five such examples are here given.

CASE 44. M M, No. 89744, a woman, aged 24 years, was admitted to Rochester Municipal Hospital on May 20, 1934, because of vomiting, loss of appetite, loss of strength, and a loss of 20 pounds in weight during the previous month. This followed an attack of influenza. Examination was negative except for slight anemia, Wassermann was 4 plus, cholecystogram was normal. The gastro-intestinal series revealed a small hernia through the esophageal hiatus. There was a gradual improvement under medical treatment.

CASE 45. H M, No. 89022, a male, aged 44 years, was admitted to Strong Memorial Hospital on May 6, 1934, because of vomiting. For 8 to 9 years the patient suffered with epigastric oppression which was relieved by soda and eructations. He had been well till 5 days previously, then nausea set in, which was relieved by soda, but he had been vomiting repeatedly since. He had had chancre 15 years before and occasional transitory pains in the heels, Wassermann was 2 plus. At examination findings were normal. The gastro-intestinal series revealed a hernia of the stomach through the diaphragm but no ulcer. Under rest, diet, and drugs he became symptom free and was discharged. The patient returned in 5 days with a recurrence which was again controlled when he was put on an antiluetic treatment.

CASE 46. F K, No. 25149, a male, aged 57 years, was admitted to Strong Memorial Hospital on June



Fig. 29. Case 57. It is advantageous to demonstrate the end of the esophagus in these cases. It shows well here and it is apparently congenitally shortened. The diaphragm levels are well seen below in this lateral view.

acidity was normal. The gastro intestinal series revealed no evidence of ulcer or cancer. There was a herniation of the fundus through the esophageal hiatus. She improved under medical treatment and was reassured regarding cancer.

CASE 36. Y. K. No 30360 a woman aged 52 years was admitted to Strong Memorial Hospital on December 4, 1929. Four weeks previously she awakened feeling weak, nervous and dizzy and these symptoms persisted. Her physician sent her to the hospital because of blood in the stools. Examination revealed varicose veins, hallux valgus, kyphosis and secondary anemia. The gastro intestinal series showed a herniation of the cardiac end of the stomach through the esophageal hiatus. There was no evidence of gastric ulcer or cancer. Barium enema was negative. Proctoscopic inspection revealed hemorrhoids only and the patient was discharged for medical care.

Cases 37 and 38 had definite evidence of diseased gall bladders in addition to the gastric complaints.

CASE 37. C. M. No 70195 a man aged 53 years was admitted to Rochester Municipal Hospital on January 12, 1933. He gave a history of stomach trouble dating from typhoid 23 years previously. Ever since he had a dull heavy feeling in the mid epigastrium, heart burn, belching, occasional nausea

and vomiting which gave relief. Discomfort was not relieved by meals but was aggravated instead. He dreaded the thought of eating but had gained in weight in the last 155 years. When he bent forward he had a feeling that everything would come out of his mouth. Examination showed a man well developed and nourished with slight hypertension and hemorrhoids. The impression was gastric lesion and cholecystitis. The gastro intestinal series revealed a herniation of the stomach through the esophageal hiatus. The cholecystogram showed chronic cholecystitis. He received symptomatic treatment and improved. He now has occasional attacks of burning which are relieved by soda and diet.

CASE 38. H. S. No 126260 a male aged 77 years was admitted to Strong Memorial Hospital on April 3, 1937. He had been well till 3 years previously when he began to lose weight. Six days before admission he felt a sudden, progressively severe epigastric pain coming on while at rest which radiated over the entire upper abdomen, more to the right than to the left. Later vomiting occurred with tarry black material and continued nausea. He was afraid to eat and lost weight rapidly. He had a similar attack 20 years before and suffered with typhoid at 45 years of age. There was fullness and tenderness in the right upper quadrant and epigastrium and blood in the stools. The gall bladder test was positive for stones. He had evidence of myocardial damage. The gastro intestinal series revealed a large diaphragmatic hernia and a diverticulosis of the large bowel. Rapid improvement was brought about under medical treatment.

In case 39, the large fundus herniation was discovered when barium was given by mouth to check on the possibility of a partial obstruction of the small bowel. The patient had had a resection for carcinoma of the rectum 1 year previously.

CASE 39. J. M. No 106067 a woman aged 67 years was admitted to Strong Memorial Hospital on August 11, 1936. In August 1935 she had been in the hospital for resection of carcinoma of the rectum. Since discharge she had had cramp-like pains 2 to 3 times a week located around the umbilicus on the right followed by diarrhea. She had gained 13 pounds since she was discharged from the hospital. General examination was not remarkable. The colostomy opening was redundant. The gastro intestinal series showed a diaphragmatic hernia of the stomach through the esophageal hiatus. There was fixation and slight obstruction due to diaphragm spasm. There was no intestinal obstruction in the small bowel. The patient improved under careful regulation of diet and catharsis.

When patients have reached later life and other diseases are actually present, the accu-

showed chronic bronchitis, emphysema and arteriosclerotic heart disease. In the course of her examination, a diaphragmatic hernia through the esophageal hiatus was noted. It was chiefly seen on deep inspiration, on coughing or straining. She was asymptomatic in the hospital (Fig. 18).

CASE 50 B D, No 23844, a woman, aged 58 years, was admitted to Strong Memorial Hospital on March 6, 1935. Two years previously she had complained of increasing fatigue, gain in weight, shortness of breath on stair climbing, also attacks at night in which she feared death. These attacks consisted of severe lancinating pains and soreness of the right costal margin. After large meals there was indigestion with pressure upward on the left side which could be relieved by belching. Several months before she developed a dull, non-radiating pain in the left upper quadrant. It was more marked on exertion and on lying down. If it came on in recumbency, she got some relief by getting up. The condition gradually grew worse. Examination showed moderate anemia and obesity. The gastro-intestinal series revealed a large para-esophageal hernia and possible gastric ulcer. She had been comfortable under medical regimen (Fig. 19).

CASE 51 D B, No 21060, a woman, aged 77 years at last admission, was first admitted to Strong Memorial Hospital on January 11, 1929. She has had 4 admissions since, mainly for cardiac and diabetic complaints. She was thought to have chronic cholecystitis because of resistance and tenderness in the right upper quadrant. Cholecystogram was within normal limits. The gastro-intestinal series showed a herniation of the upper portion of the stomach through the esophageal hiatus. It produced no motility disturbance (Fig. 20).

CASE 52 C K, No 72927, a woman, aged 67 years, was admitted to Rochester Municipal Hospital on March 20, 1933, for frequency, dysuria, and pain in the right side which lasted 4 months. Stereopyelogram showed ptosis of the right kidney with hydronephrosis, and double ureter on the left side. For 25 years she had had attacks of severe epigastric pain and vomiting. The pain grew worse at night and was somewhat relieved by lying on the left side. A cholecystectomy had been performed 27 years previously. Examination revealed an emphysematous chest, hypertension, a scar in right upper quadrant, and a palpable right kidney. The gastro-intestinal series showed herniation of a large portion of the stomach through the esophageal hiatus. Symptomatic treatment only was given (Fig. 21).

CASE 53 M B, No 48659, a woman, aged 66 years, was admitted to Strong Memorial Hospital on June 24, 1931, because of weakness, anemia, excessive gas, and constipation for 1 year. There had been occasional icterus and clay colored stools, also sharp pain under the right costal margin and into the low back. The patient had lost 15 pounds in weight and had had colitis and dysentery for 5 years. Examination revealed the patient to be overnourished with moderate anemia, slight enlargement of

the heart, mild hypertension, and guaiac positive stools. The gastro-intestinal series showed the entire cardia through the diaphragm. Medical treatment gave relief (Fig. 22).

The partial thoracic stomach which extends through the esophageal hiatus may also give puzzling signs. In consequence, diagnosis of pulmonary cavity, pleural fluid, thickened pleura, bronchiectasis, pneumonia, mediastinal tumor and pulmonary carcinoma have been made in these cases.

The roentgenogram again furnishes the complete evidence and often demonstrates a bizarre arrangement of the organs in the thoracic cavity. Case 54 is a typical example of a thoracic stomach. The flat plate shows a large cystic area in the lower right thorax. It has a fluid level. The lateral view shows it to be 2 gastric pouches; and the barium demonstrates that the whole stomach occupies the right lower thorax. The greater curvature of the stomach is to the right and the cardia, pylorus, and lesser curvature toward the medial side.

CASE 54 B R, No 9809, a woman, aged 46 years, was admitted to Rochester Municipal Hospital on October 16, 1936. She had had gaseous indigestion for 4 years, and 2½ years previously nausea and vomiting occurred 1 hour after meals. This condition was relieved somewhat by soda. There was an increasing burning pain in the epigastrium. In the past 2 years she had lost 30 pounds in weight and felt full after she had taken a small amount of food. She had received treatment without avail. For 24 years she had suffered with rheumatism and had well developed, crippled joints, an enlarged thyroid, and moderate hypertension. There was a dull percussion note in the right lower lobe, posteriorly; breath sounds were diminished, vocal fremitus and tactile fremitus were present in the same area, and there was a splashing sound heard after shaking the chest. Laboratory findings were negative. A diagnosis suggested stomach ulcer or cancer and right pleural effusion. The gastro-intestinal series showed a right-sided intrathoracic stomach with a large out-pocketing along the lesser curvature, probably a diverticulum. Medical treatment was advised (Figs 23, 24, 25).

Case 55 illustrates the rotation of a major portion of the stomach in the thoracic cavity with only a small portion of the pyloric end subdiaphragmatic.

CASE 55 T N, No 110808, a woman, aged 61 years, was admitted to Rochester Municipal Hos-



3 1929 He gave a history of mid epigastric pain for 3 months a dull steady, nearly constant pain sharply localized high in the mid epigastric. Occasionally it was parasternal given to acute exacerbations which was precipitated by varying postural changes, and relieved in the same manner and by rest. Examination showed enlarged glands slightly enlarged heart, moderate sclerous pupils sluggish to light, arthritis especially of the dorsal spine, and Wassermann 4 plus. The gastro intestinal series revealed a hernia through the esophageal hiatus. Pain was controlled largely by antiluetic treatment. Occasional attacks like indigestion lasted 1 hour.

CASE 47 M B, No 122835 a woman, aged 40 years was admitted to Strong Memorial Hospital on December 28, 1936. At a previous admission in February, 1936 examination revealed a mild, toxic nodular goiter. Since then there had been symptoms of indigestion gas occasional right upper quadrant pain palpitation, and transient dizziness. Improvement was brought about with belladonna. The patient was nervous, emotional, with a large thyroid, but otherwise was normal physically. Wassermann tests on 3 occasions were one plus, two plus and negative respectively. The gastro intestinal series showed a small diaphragmatic hernia at the cardia. The patient complained of pain on deep inspiration as the stomach herniated. There were associated cardiospasm and pylorospasm. She was put on medical treatment with still persisting mild symptoms.

CASE 48 J B, No 1736 a male aged 52 years was admitted to Strong Memorial Hospital on July 7 1926. For 3 years the patient had a run down feeling and in June 1925, had to give up work because he was weak and anemic. He was treated for pernicious anemia until January 1926, but there was a gradual decline through winter with vague stomach and chest pains. The patient had had chancres 32 years previously. Patient was sallow, and had peculiar rumbling sounds over the precordium. There was a percussion note at times tympanic over the heart region splashes and clicks synchronous with heart beat, tenderness in the epigastrum, and absence of knee jerks and secondary anemia. Wassermann 4 plus. The gastro intestinal series showed a diaphragmatic herniation of stomach and diverticulum of stomach below the diaphragm. The patient was put on antiluetic treatment and improved.

In Case 48 the roentgen ray demonstrated a very unusual picture. In addition to the large intrathoracic sacculization, which appeared like a cystic area in the lower left chest there was also a diverticulum extending laterally from the greater curvature below the diaphragm. Figs 16 and 17.

The diagnosis can be suspected from the symptoms and signs. It is clinched by the

roentgen examination. Barium may be necessary in a gastro intestinal series or in a clyster in order to show the lesion. The esophageal hiatus hernias can be noted occasionally in the upright position, but usually the lesion is much more pronounced when the patient is reclining. It may even require deep inspirations to demonstrate the small portion of the cardia above the diaphragm. Sometimes the air bubble will be sufficient to outline the herniation (Fig 18). As a rule a swallow of barium demonstrates the lesion accurately. This must be differentiated from cardiospasm, and diverticulum of the esophagus. It is simplified when the rugæ of the cardia can be traced directly into the sacculization across the intervening diaphragm which causes a constriction about the area (Fig 12). It is often surprising how large a portion of the stomach can be demonstrated above the diaphragm when the patient is prone, only to have it completely subside below the diaphragm level on standing (Fig 20).

Esophagospasm (Fig 11) and cardiospasm are often associated, and frequently pylorospasm as well. This makes the diagnosis of intramural gastric lesions difficult. The barium by mouth will many times give definite fluid levels, indicating the partial stasis which is present in some of these stomachs (Figs 13 and 14). Transition to the true thoracic stomach can be determined only by demonstration of the length of the esophagus. If it is present and curled back upon itself so that the stomach could be put back below the diaphragm if necessary, the case is a true hiatus hernia (Fig 11). In the true thoracic stomach the esophagus is congenitally shortened, making subdiaphragmatic restoration of the stomach impossible. Consequently, it is important to visualize completely the esophagus in all these patients. Some hiatus hernias contain a large portion of the stomach (Figs 21 and 22). Cases 49 to 53 show the radiographic appearances described above.

CASE 49 G R, No 120760 a woman aged 67 years was admitted to Strong Memorial Hospital on October 30, 1936. She had had jaundice with fever at 19 years of age. Appendectomy had been performed 12 years previously. Her present admission was concerned with attacks of bronchitis. There were no symptoms referable to the stomach. Examination

catheter through the hernia opening to equalize the pressure was suggested by Mayo. It is a useful procedure in a difficult case.

Minor types of esophageal hiatus hernia may be relieved by simple phrenic nerve block though this is not always successful. This method is also applicable to very old or debilitated patients who will not stand a procedure of greater proportions. Care should be taken to determine just what position the stomach and esophageal junction will assume. In case this is not done the angulation between the esophagus and the stomach may be increased and the symptoms may become worse. The excellent studies of Lichtenstein on this question should be known to surgeons contemplating this procedure. At times the right phrenic probably should be the nerve temporarily paralyzed (19).

In some cases of thoracic stomach in which there is a pinch-cock action of the edges of the diaphragm on the herniated organ, a phrenic block will give relief (Case 57). In other cases, no benefit follows this procedure (Case 58).

When the spleen is adherent inside the sac of an esophageal hiatus hernia, it may tear easily if handled while the respiratory excursions are greatly forced. This forms a complication which may be very serious. The spleen should either be sutured if possible (Case 14) or removed if necessary under such circumstances.

#### BIBLIOGRAPHY

The bibliography is abridged to those references which proved most useful to the author in preparing this paper.

1. AKERLUND, A. Hernia diaphragmatica Hiatus oesophagi vom anatomischen und roentgenologischen Gesichtspunkt, Oehnell, H., Klinischen Gesichtspunkt, Key, E., Therapeutischen Gesichtspunkt, Kasuistik, Literaturverzeichnis. *Acta Radiol*, 1926, 6, 3-68.
2. BOWEN, A. Volvulus of an inverted intrathoracic stomach complicating diaphragmatic hernia. *Am J Digest Dis*, 1937, 3, 923-928.
3. BROWN, S. The roentgenologic study of the diaphragm. *J Am M Ass*, 1931, 97, 678-682.
4. CHRISTIANSEN, H. A Case of hematemesis in an infant due to esophageal orifice hernia. *Acta Radiol*, 1937, 18, 77-80.
5. CLERF, L. F., and MANGES, W. F. The congenitally short esophagus. *J. Am M. Ass*, 1934, 102, 2008-2012.
6. CLOPTON, M. B. Eventration of the diaphragm. *Ann Surg*, 1923, 78, 154-163.
7. DONOVAN, E. J. Congenital diaphragmatic hernia. *Ann Surg*, 1938, 108, 374-388.
8. DWYER, M. F. Hernia of cardiac end of stomach through diaphragm. *Radiol*, 1937, 28, 315-324.
9. FRIEDENWALD, J., and FELDMAN, M. Report of an interesting type of diaphragmatic hernia of the cardia of the stomach through the esophageal orifice. *Am J M Sc*, 1925, 170, 263-271.
10. GARRAUD, R., and BASTIEN, P. Hernies des viscères abdominaux à travers les orifices normaux du diaphragme (Hernies Diaphragmatiques Vraies de Adams). *Ann d'anat path*, 1936, 13, 603-622.
11. GILLESPIE, J. B. Congenital shortening of the esophagus. *J Pediat*, 1936, 8, 38-40.
12. VON GREYERZ, W. Hernia diaphragmatica retrosternalis. *Acta Radiol*, 1937, 18, 428-438.
13. HARRINGTON, S. W. Diaphragmatic hernia associated with traumatic gastric erosion and ulcer. *Surg, Gynec & Obst*, 1930, 51, 504-521.
14. Idem. The diagnosis and treatment of diaphragmatic hernia. *J Thoracic Surg*, 1931, 1, 24-43.
15. Idem. Diaphragmatic hernia. *J Am M Ass*, 1933, 101, 987-994.
16. HEDBLUM, C. A. Diaphragmatic hernia. *J Am M Ass*, 1925, 85, 947-953.
17. KERR, H. D., and STEINBERG, S. S. Right-sided diaphragmatic hernia. *Am J Roentgenol.*, 1935, 34, 735-739.
18. LEMAITRE, L. Hernie diaphragmatique du colon transverse. *L'Echo med du nord*, 1930, 34, 49-52.
19. LICHTENSTEIN, H. Form- und Lageveränderungen des Magens nach Phrenicusexarese. *Beitr z Klin. d Tuberk*, 1932, 80, 509-522.
20. ORR, T. G., and NEFF, F. C. Diaphragmatic hernia in infants under one year of age treated by operation. *J Thoracic Surg*, 1936, 5, 434-440.
21. THOMAS, C. C. Non-traumatic diaphragmatic hernia with report of case of congenital right-sided hernia. *Radiol*, 1937, 28, 608-613.
22. TRUESDALE, P. E. Diaphragmatic hernia in children with a report of thirteen operative cases. *New England J Med*, 1935, 213, 1159-1172.
23. TRUESDALE, P. E. Diaphragmatic hernia. *Am J Surg*, 1936, 32, 204-216.
24. WOOLSEY, J. H. Diaphragmatic hernia. *J. Am. M. Ass*, 1927, 89, 2245-2248.

pital on January 10 1936 She had lost 50 pounds in 6 months Five months previous she had had a watery diarrhea associated with nausea, bloating and loss of appetite There was extreme weakness, palpitation, dyspnea and spots before the eyes Three weeks before admission she had a second bout of diarrhea with blood in stool and had fainted several times recently At 15 years of age he had typhoid and had an appendectomy performed 30 years previously Examination revealed pallor, pyorrhea, moderate emaciation, severe secondary anemia, complete achlorhydria, chronic cholelithiasis (intravenous cholecystogram) and pancreatic calculi The gastro-intestinal series showed short esophagus, cardia of the stomach above the diaphragm, body of the stomach curled upward for 15 to 20 centimeters behind the heart and to the right of cardia portion then downward and to the left through the diaphragm Only one fifth to one sixth of the entire stomach was below the diaphragm She gradually became worse Ascites developed with thrombosis of the left iliac Death occurred on March 3, 1936 Anatomical diagnosis revealed multiple pancreatic calculi with complete atrophy, tuberculosis of the peritoneum, diaphragm, left pleura, spleen, and right adrenal, multiple pulmonary emboli and herniation of the stomach through the diaphragm (Fig. 26)

Cases 56 and 57 show further variations in these gyrating, twisting, gastric herniations above the diaphragm

CASE 56 A W, No 116904 a woman, aged 72 years, was admitted to Strong Memorial Hospital on August 2 1936 The patient gave a history of pain in the stomach and right upper quadrant with a sudden onset 8 years previously of spells of nausea and persistent vomiting repeated frequently since There was a swelling in the right epigastrium at onset and at varying intervals There was also much pain, which was relieved by vomiting Vomitus contained blood and stools were tarry She was unable to retain solid food Her last severe attack occurred 6 months before The patient lost 18 pounds in 2 years Examination revealed the patient to be senile with general arteriosclerosis, hypertension, arteriosclerotic heart disease, and tenderness in the epigastrium The gastro-intestinal series showed herniation of the stomach through the esophageal hiatus 6 centimeters of fundus above the diaphragm irreducible, and marked pylorospasm There was a suggestion of ulceration at the level of the diaphragm and also in the duodenum Owing to age and general poor condition phrenic nerve block was done under local anesthesia She did not have any improvement following this therapy There were many unrelated aches and pains in all parts of the body (Figs 27, 28)

CASE 57 M No 127376 a female aged 55 years was admitted to Strong Memorial Hospital on May 10 1937 Three years before there was an on-

set of severe epigastric pain during meal or immediately after which was relieved by drinking water or by vomiting This occurred once or twice a week with belching and flatulence Roentgenogram showed a diaphragmatic hernia and diverticula in the large bowel Medical treatment was administered but symptoms increased Occasional pain radiated to the left shoulder Examination was essentially normal The gastro-intestinal series showed about three fourths of the stomach intra-thoracic and posterior with pinch cock action at the lower end of the stomach A left phrenic nerve crush was employed and the patient obtained some relief (Fig. 29)

The esophageal hiatus type may be very difficult surgery It may require approach through the chest or from the abdominal side Sometimes, even when approached from both angles, it is practically impossible to visualize a small sac In such a case, packing may be successful in causing adhesions with relief of symptoms Case 58 is an example

CASE 58 S H, No 6859 a woman aged 43 years was admitted to Strong Memorial Hospital on July 6, 1932 For 6 years she suffered attacks of vomiting accompanied by knife like pain in the left upper quadrant radiating to the infrascapular region Attacks occurred usually at night lasting several hours These were accompanied by a bloated feeling in the epigastrium and severe eructations Cholecystectomy and appendectomy were performed 4 years previously with relief for 3 months For the last 4 years she had been vomiting nightly with severe colic like pains She obtained no relief from food or soda and there was blood in the vomitus occasionally during the last 6 months A diagnosis of duodenal ulcer was made 1 year before Examination revealed the patient to be very obese There was gas gurgling and she was belching almost continually The gastro-intestinal series was negative except for herniation of the stomach through the esophageal hiatus Operation was performed by abdominal route by transthoracic and by both It was impossible to visualize the opening though it could be palpated Drains were inserted into it from the abdominal side Nausea and vomiting disappeared and the patient could eat anything She has had relief from her symptoms since discharge from the hospital

The operation described by Harnington is very useful (14, 15) Temporary paralysis of the diaphragm greatly facilitates the task of repair The edges should be approximated with care It is not necessary to suture into the esophagus if the repair is properly earned out Fruesdale has given some excellent advice in this regard (23) The passage of a

sisted of 20 blows to 1 thigh with a heavy iron bar, the femur being broken. In their paper (15) in 1935, they state, "Our first conclusion is that a toxemia, due to the elaboration of histamine or any other depressor substance manufactured in the traumatized area, plays no part in the syndrome of traumatic shock. We regard the 2 remaining factors, local fluid loss and the discharge of nociceptive nervous stimuli, as the effective etiological agents. The evidence does not allow us to dogmatize as to the relative importance of these factors, although we are inclined to believe that the nervous factor dominates the picture." In a later communication (18), they state, "The initial depressor effect of trauma is due to fluid loss; the significant secondary decline to shock is caused by the continued and continuous discharge of nervous impulses from the traumatized area. The nervous factor alone can cause death. The fluid loss in these experiments, provided the nervous factor is controlled, is not fatal." Their methods differ in the main from those of others in that chloralose was used as the anesthetic and the blows were inflicted with an iron bar rather than a hammer or mallet.

Of the many types of experiments performed by O'Shaughnessy and Slome, the two following types seem to be the most significant. It was found that the induction of spinal anesthesia has a most favorable influence in delaying and even preventing the onset of shock in cats anesthetized by chloralose. Second, they found that shock followed trauma to an extremity of an animal in which the limb received its circulation from a second cat. Bell, Clark, and Cuthbertson were unable to repeat these latter findings on cats anesthetized by nembutal. They state, "In none of the experiments was there any evidence that traumatization of the recipient's transfused limb caused anything but a temporary disturbance of the recipient's blood pressure. This is directly opposed to the finding of O'Shaughnessy and Slome. In their 2 recorded cross-circulation experiments, the recipients went into shock and died, and in 1 they found that trauma caused death of the donor some 2 hours after the injury and actually before the recipient went into shock."

A number of experiments have been performed previously which may have a bearing on their observations on the use of spinal anesthesia. Parsons and Phemister found that the traumatization of denervated limbs of dogs resulted in low blood pressures similar to those produced in animals whose limbs were not denervated. As stated, Freedlander and Lenhart obtained similar findings in cats. Blalock (4) found that trauma produced its characteristic effects in dogs after spinal anesthesia had been induced. Holt and Macdonald (12) have found no evidence which supports the view that nociceptive nervous stimuli from the injured tissues dominate the picture in dogs anesthetized with sodium barbitone.

The present investigation consists of an attempt to assess the parts played by fluid loss and by nervous impulses in the onset of shock due to trauma. As stated, O'Shaughnessy and Slome used chloralose as the anesthetic and therein may rest the explanation for the discrepancy between their results and those of others. For this reason, the effects of the same procedures under chloralose and under nembutal anesthesia have been compared. It may not be amiss at this point to quote several authorities on the properties of chloralose. Cushny (7) states that chloralose is a sugar compound of chloral which acts much more like morphine than like chloral. It depresses the psychical functions while increasing the reflexes until convulsions resembling those of strychnine may be produced. Sollman states that chloralose is often contaminated with non-hypnotic but toxic paral-chloralose. It is stated in the *United States Dispensary* (20) that the action of chloralose is variable and that it may produce collapse, convulsions, or pronounced disturbances of respirations.

#### METHODS AND RESULTS

The experiments were all performed on cats or dogs and chloralose or nembutal was used as the anesthetic. The anesthetic was introduced intravenously. The initial dosage per kilogram of body weight of chloralose was 0.08 grams and of nembutal was 0.025 grams. In the course of the experiment additional doses were given as required. There was no

# EXPERIMENTAL TRAUMATIC SHOCK FURTHER STUDIES WITH PARTICULAR REFERENCE TO THE RÔLE OF THE NERVOUS SYSTEM

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MUCH experimental work has been done on the shock that is associated with trauma to an extremity. This method (5) is of particular value in that the opposite extremity may be used as a control and the loss of blood into the injured part may be determined (2). Unfortunately in some instances, the results of such experiments have been interpreted by the investigator himself, or more often by the reader, as explaining all types of shock. This has led to confusion as there are several types of shock and all instances cannot be explained satisfactorily by one theory. The terms hematogenic, neurogenic, and vasogenic have been suggested (3) as names for the different types. Many instances of shock are probably combinations of 2 or all of these.

The 3 most popular theories at the present, as to the causation of shock, maintain that it is due to toxemia, to local fluid loss or to nervous stimuli. It is likely that all 3 of these agencies enter into the production and maintenance of some cases of shock. The most important point is to determine the agency or agencies responsible for the development of shock as there are probably countless factors which serve to maintain it after it is fully developed. If our remarks are limited to the shock that follows severe trauma to an extremity of an experimental animal, it would seem from many recent experiments that toxemia as an important initiating factor has been excluded. Dale stated recently, "With regard to the possible rôle of histamine, we know now what we did not know then, that

of all the major tissues of the body, the muscles contain least of that substance. What ever else it may have been, the shock following the Bayliss Cannon limb trauma was not histamine poisoning." However, this does not mean that the possibility of the absorption from injured tissues of substances which act slowly and over a long period has been excluded. There is good evidence that deaths which occur a number of days following burns are due in part at least to the action of toxic products.

It was found by Blalock (2) and by Parsons and Phemister that severe trauma to an extremity of a deeply anesthetized dog was associated with the loss of a sufficient part of the blood volume into and near the traumatized area to account for the decline in the blood pressure. These findings have been confirmed by Freedlander and Lenhart, by Holt and Macdonald and by others. Freedlander and Lenhart in their experiments used cats anesthetized by the intramuscular injection of sodium barbital in which the degree of injury was carefully controlled. They state, "With this large series as a control, experiments were conducted to exclude all the nervous connections of the extremity to be traumatized. In order to accomplish this, recovery experiments were done in stages, cutting the cord, the peripheral nerves, and the sympathetic chain. These completely denervated limbs responded to trauma like the controls. The shock following trauma can be explained on the basis of hemorrhage and local fluid loss."

Simonart concluded as a result of experiments on cats that an intact nerve supply is essential for the development of traumatic shock. Recently O'Shaughnessy and Slome have performed many experiments on cats anesthetized by chloralose. The trauma con

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and non-traumatized extremities in the animals which received spinal anesthesia was 2.87 per cent of the body weight while that in those without the spinal was 3.59 per cent. A decrease in the concentration of the red blood cells occurred in most of the experiments.

As has been stated, the blood pressure in these experiments was determined by puncturing intermittently the exposed carotid artery with a needle which was connected to a mercury manometer. Cats survive longer as a rule when this method is used instead of placing a cannula in the carotid. This may be due to the loss of blood that occurs when it is necessary to wash out the cannula due to the clotting of blood.

*Nembutal* There were 16 experiments of this type on cats anesthetized by nembutal. Trauma in all instances consisted of 20 blows with an iron bar thus breaking the femur. The blood pressure was determined in the carotid artery by the needle puncture method. Eight animals served as controls and the other 8 were given spinal anesthesia before the trauma and every 30 minutes afterward for 7 or 8 hours. Six of the 8 animals which received no spinal anesthesia were alive at the end of 24 hours and were killed. The blood pressure was definitely depressed in 2 of these. One of the 8 died 4 hours and 35 minutes following the trauma and the remaining animal lived 22 hours and 30 minutes. The animal with the short survival period was extremely anemic, the control hematocrit reading being 17 and it declined to 13. The average difference in the weights of the traumatized and non-traumatized extremities in the 7 experiments in which it was determined equalled 3.55 per cent of the body weight. Six of the 8 animals that received a spinal anesthetic were alive at the end of 24 hours and were killed. The blood pressure was definitely depressed in 3 of these. The 2 remaining animals died 21 hours following the trauma. The average difference in the weights of the traumatized and non-traumatized extremities in the 6 experiments in which it was determined was 3.03 per cent of the body weight. The results in the 2 types of experiments, with and without a spinal anesthetic, were practically identical. There was very little altera-

tion in the hematocrit reading in 11 of the 16 experiments, a moderate rise in 1 and a moderate decline in 4.

#### GROUP II. DOGS. TRAUMA, CHLORALOSE, WITH AND WITHOUT SPINAL ANESTHETIC

As has been stated, O'Shaughnessy and Slome produced shock in cats by striking the thigh 20 blows with an iron bar thus breaking the femur. This method was used in our first 6 experiments on dogs anesthetized by chloralose. Two of the animals did not develop shock and were killed approximately 26 hours subsequently. The average survival of the 4 remaining animals was 9 hours and 45 minutes, the time ranging from 55 minutes to 20 hours. The difference in the weights of the 2 extremities ranged from 3.14 to 5.23 per cent of the body weight, the average being 4.19 per cent. Fourteen experiments were then carried out in which the traumatization consisted of 40 blows with an iron bar, the femur being broken. Two of these animals were not in shock 23 hours subsequently and were killed. The survival period in the 12 remaining experiments varied from 2 to 25.5 hours, the average being 9 hours and 37 minutes. The difference in weights of traumatized and non-traumatized extremities varied from 1.19 to 4.85 per cent of the body weight in the different experiments, the average being 3.23 per cent. All of the animals showed an increase in the concentration of the red blood cells. Addition of the 2 types (20 and 40 blows) shows that the average survival period in the 16 experiments in which trauma resulted in shock was 9 hours and 32 minutes and the average difference in weights of the extremities was 3.47 per cent.

The second type of experiment was similar to that just described except that spinal anesthesia was administered before the traumatization and every 30 minutes thereafter unless the animal lived longer than 7 or 8 hours. There were 5 experiments in which the injury consisted of 20 blows with an iron bar. Two of these did not get a marked decline in blood pressure and were killed at 6 and 10 hours, respectively, following the injury. The 3 remaining lived 5 hours and 40 minutes, 8 hours, and 17 hours and 20 min-

evidence of pain during the course of the experiments. The arterial blood pressure was determined in most instances by the use of a carotid cannula which was connected to a mercury manometer. In the remaining experiments, the exposed carotid artery was punctured with a needle which was connected to a manometer. The trauma consisted of striking the thigh with an iron bar, as used by O'Shaughnessy and Slome, thus breaking the femur. The increase in the weight of the traumatized extremity was determined by the amputation method (2) which was described previously by one of us. In the experiments in which spinal anesthesia was induced, the fluid was introduced intrathecally in the lower lumbar region. The dosage of the spinal anesthetic was the same as that used by O'Shaughnessy and Slome (15), namely, 1.66 milligrams novocain in 0.3 cubic centimeters of water per kilogram of body weight. The methods used in the cross circulation experiments were similar to those employed by O'Shaughnessy and Slome (15). The distal ends of the divided femoral artery and vein of 1 animal (recipient) were anastomosed by suture to the proximal ends of the carotid artery and external jugular vein of a second animal. The extremity of the recipient was then rendered *anemic* by the method of O'Shaughnessy and Slome, namely, ligation of the abdominal aorta, ilio-lumbar artery, middle sacral, external iliac, profunda femoris, the femoral artery and its branches in the groin and the veins corresponding to these arteries. Following this, the clips were removed from the vessels which had been connected by suture and the extremity was traumatized. According to O'Shaughnessy and Slome, the traumatized extremity receives blood only from the second animal and yet the reflexes are maintained intact.

Several different groups of experiments were performed.

#### GROUP I. CATS TRAUMA, WITH AND WITHOUT SPINAL ANESTHETIC

**Chloralose.** These experiments were performed in pairs. Both cats received chloralose and 1 of the 2 received a spinal anesthetic before and at 30 minute intervals following

the traumatization for a period of 7 to 8 hours. The trauma consisted of 20 blows with an iron bar thus breaking the femur. Sixteen cats were used in this study, thus making 8 complete experiments in which animals with and without the spinal anesthetic were compared. The animal with the spinal anesthetic lived longer than the control animal in 6 of the 8 experiments, the reverse was true in 1 experiment and there was no difference in the remaining 1. There seemed to be little doubt that cats anesthetized with chloralose withstand trauma to a posterior extremity better if a spinal anesthetic is administered before and following the trauma. The results in the 16 experiments were as follows: Three of the cats with the spinal anesthetic were killed 25 or more hours following the traumatization. The blood pressure of only 1 of the 3 was markedly depressed. The average survival of the 3 remaining was 18 hours and 50 minutes and the average fluid loss in these equalled 3.12 per cent of the body weight. Of the cats without spinal anesthesia, 1 had a normal blood pressure 26 hours after the traumatization and was killed. The average survival of the 7 remaining was 13 hours and 15 minutes and the average difference in weights of the traumatized and non traumatized extremities equalled 3.26 per cent of the body weight. A moderate decrease in the concentration of the red blood cells was found in most of the experiments.

O'Shaughnessy and Slome found that the giving of a spinal anesthetic to cats already in shock as a result of trauma increased the survival period. These experiments were repeated on 5 pairs of cats. Shock was produced in the usual manner. After the blood pressure reached a shock level, 1 cat in each group was given a spinal anesthetic and this was repeated every 30 minutes. There was no difference in the survival period of the 2 cats in 2 of the 5 experiments, the cat without spinal anesthesia survived longer than the other in 2 of the experiments and the reverse was true in the remaining experiment. The experiments do not support the contention that a cat already in shock is benefited by the giving of a spinal anesthetic. The average difference in the weights of the traumatized

regards the length of life, since the donor lived longer than the recipient in 1, the recipient lived longer than the donor in 1, and they died at approximately the same time in another. Both the donor and recipient showed a moderate increase in the concentration of the red blood cells. The traumatized leg of the recipient was heavier in each instance than the opposite leg and in terms of percentage of body weight of the donor this difference was 1.92, 3.94, and 3.07 per cent respectively, in the 3 experiments.

Similar experiments were performed on dogs anesthetized by nembutal. There were 3 experiments, in 1 of which the trauma was repeated. The blood pressure of the donor declined during the traumatization while that of the recipient remained the same or rose. There was a moderate increase in the concentration of the red blood cells in both the donor and recipient. The traumatized animal (recipient) lived longer than the donor in 2 of the experiments and the 2 animals died at approximately the same time in the remaining experiment. The traumatized leg was heavier than the control in each instance and equalled 2.26, 3.2, and 4.8 per cent of the body weight of the donor in the 3 experiments.

In 3 experiments, the procedure consisted of traumatizing a leg which had been amputated except for the obturator, femoral, and sciatic nerves. This leg was supplied with arterial blood from a second animal by the usual technique. Chloralose was used in 2 of the experiments and nembutal in the third. The donor and recipient died at approximately the same time in the 2 experiments in which chloralose was used. The blood loss into the traumatized extremity equalled 3.6 per cent of the weight of the recipient in 1 of these experiments and was insignificant in the other. In the experiment in which nembutal was used, the donor died 2 hours following the traumatization. The blood pressure of the recipient (traumatized animal) was normal 3 hours later and the experiment was terminated.

The cross-circulation experiments were so inconclusive that it was decided that control experiments on the effects of the anemic-limb preparation should be performed.

#### GROUP V. ANEMIC-LIMB PREPARATIONS

These experiments were performed on dogs and cats, some being anesthetized with chloralose and others with nembutal. Six experiments were carried out on cats anesthetized with chloralose in which the effects of the anemic-limb preparation alone on the blood pressure, reflexes, and length of life were determined. The blood pressure was determined by a cannula in the carotid artery. Five of the 6 animals died in less than 13 hours after the limb had been rendered anemic, or in 13, 9, 6.5, 4, and 3 hours, respectively, an average of 7.1 hours. The blood pressure was usually at a fairly high level until shortly before death, which in several instances was fairly characteristic of respiratory failure due to anesthesia. The sixth or remaining animal was removed from the table after 24 hours in good condition, and in this cat the knee jerks did not disappear. Neither did they disappear in 4 of the 5 remaining animals until shortly before death. In the remaining cat, the knee jerks of the anemic limb disappeared 2 hours after the operation, the animal living 2 hours longer. There was a slight increase in the concentration of the red blood cells in most of the experiments.

Six experiments of the same type were performed on cats in which nembutal was the anesthetic. The length of life after rendering the limb anemic varied from 4 to 13 hours, the average being 8 hours. The length of time that the knee jerks persisted was variable. In 2 animals they did not disappear until a short time before death. A rather marked increase in the concentration of the red blood cells occurred in 3 of the 6 experiments. The high incidence of persistence of reflexes in this and the preceding type of experiment is to be explained at least partially by the fact that trauma was to have been instituted in some of them if the reflexes had disappeared. It is quite possible that the duration of life would have been greater in these cats if the blood pressure had not been determined by cannula which had to be washed out several times during the course of the experiments. In 3 additional experiments on the anemic-limb preparation in which the blood pressure was determined by needle puncture, the survival



utes, respectively, the average being 10 hours and 20 minutes. The average difference in the weights of the injured and non injured extremities equalled 2.26 per cent of the body weight. The injury in the 5 other experiments consisted of 40 blows with an iron bar. All of these animals died. The average survival period was 6 hours and 17 minutes, the individual times varying from 4 to 11 hours and the average difference in weights of the extremities equalled 3.48 per cent of the body weight. A comparison of these experiments with those in which spinal anesthesia was not given shows very little difference in the 2 groups, the survival period being slightly longer in those without spinal anesthesia.

The third type of experiment was identical with the second except that the spinal anesthesia was not given at regular intervals but was injected whenever the reflexes of the posterior extremities returned. The trauma consisted of 40 blows with an iron bar to break the femur. There were 7 experiments of this type. The blood pressure in 1 experiment remained elevated and the experiment was discontinued after 23 hours. The 6 remaining animals survived from 3 to 21 hours, the average survival period being 8 hours and 3 minutes. The average loss of fluid into the injured part equalled 3.76 per cent of the body weight. An increase in the concentration of the red blood cells was found in most of the experiments. Again, a comparison with the first or control type does not indicate that spinal anesthesia increased the tolerance to trauma.

O'Shaughnessy and Slome noted that the giving of a spinal anesthetic to a cat in shock increased the survival period. These experiments were repeated on 7 dogs anesthetized by chloralose in which shock had been produced by striking the thigh with an iron bar. The average survival period from the time of the trauma was 5 hours and 34 minutes and from the time of the injection of the spinal anesthetic was 2 hours and 33 minutes. The average difference in the weights of the traumatized and non traumatized extremities equalled 3.93 per cent of the body weight. Again, no evidence that the spinal anesthetic increased the survival time was found.

#### GROUP III DOGS TRAUMA, TRANSFUSION AFTER SHOCK LEVEL, WITH AND WITHOUT SPINAL ANESTHETIC

In experiments under chloralose, Slome and O'Shaughnessy found that a cat in shock as a result of trauma, if treated by the transfusion of blood and by spinal anesthesia, will survive longer than one treated by blood transfusion alone. We have performed 6 such experiments on dogs anesthetized by chloralose. After the blood pressure reached a shock level as a result of striking the thigh 40 blows with an iron bar, the femur being broken, each of the animals was given a transfusion of blood approximately equal in amount to that lost into the injured part and one half of the animals were given an injection of spinal anesthesia every 30 minutes. The dosage of novocain was the same as that used by Slome and O'Shaughnessy. The animals without spinal anesthesia lived longer on the average than those which were given novocain and the difference in the weights of the traumatized and non traumatized extremities was somewhat greater in the former group. Four of the 6 animals showed an increase in the concentration of the red blood cells and the other 2 showed no change.

#### GROUP IV CROSS CIRCULATION EXPERIMENTS

The procedure used was similar to that described by O'Shaughnessy and Slome. The carotid artery and external jugular vein of the donor was anastomosed to the femoral artery and femoral vein of the recipient. The anemic limb was then prepared, and following this the clips were removed from the vessels listed above, thus establishing the cross circulation. In 2 experiments on animals anesthetized with chloralose, 1 on dogs and 1 on cats, the donors lived only 2 hours following the establishment of the cross circulation and the recipients lived approximately 4 hours. The cause of death was unexplained since trauma was not instituted. In 3 experiments on dogs anesthetized with chloralose, the leg receiving the blood from the donor dog was then traumatized. The blood pressure of the donor fell during the traumatization while that of the recipient remained the same or rose somewhat. The experiments were inconclusive as

It is our impression that chloralose is a very dangerous and variable anesthetic. A number of animals were observed to die very suddenly when the blood pressure had been essentially normal a few moments before and the deaths seemed to be due to respiratory failure. This anesthetic was probably chosen by O'Shaughnessy and Slome because the reflexes usually persist after its administration and, in fact, they usually become extremely hyperactive. The cats frequently behave as though they had been given strychnine, jumping violently as a response to noise or touch. It may be that the choice of the anesthetic explains part of the discrepancy in the results of O'Shaughnessy and Slome and those of others. The cats which were anesthetized with nembutal usually maintained their knee jerks and certainly they were more nearly normal than the extremely hyperactive reflexes of the cats which received chloralose. Chloralose has much less effect on the reflexes of dogs.

Cross-circulation experiments of the type described would seem to be an ideal method by which to eliminate the factor of blood and fluid loss in response to trauma, having only the nervous factor influencing the recipient of the trauma. However, the short survival of many of the animals with an anemic-limb preparation (a necessary part of the cross-circulation experiment), particularly if chloralose is used as the anesthetic, would seem to cast doubt on the value of these studies. At any rate, our findings more nearly substantiate those of Bell, Clark and Cuthbertson than those of O'Shaughnessy and Slome. The former authors state, "By means of cross-circulation experiments it was found that trauma applied to a transfused hind limb of the recipient animal caused a marked fall in the blood pressure of the donor, followed by death within 75 minutes. The blood pressure of the recipient was practically unaffected by the injury." We have confirmed the interesting observation of O'Shaughnessy and Slome that the blood pressure of the donor falls during the traumatization while that of the recipient (traumatized animal) usually remains the same or rises slightly. This substantiates their impression that the initial fall

in blood pressure in this type of injury is due to the loss of fluid into and from the injured blood vessels. The disagreement is on the question as to why the blood pressure continues to remain depressed. It would seem that O'Shaughnessy and Slome are correct in asking the abandonment of the term, "primary shock," as applied to the early condition that follows injury to an extremity, as this and the later state are parts of one and the same picture.

In regard to the anemic-limb preparation, Slome and O'Shaughnessy state, "It was known that the onset of shock could be prevented by complete occlusion of the arterial supply of the limb prior to trauma. In this case fluid loss cannot occur; we showed that in the presence of such complete 'ischemia,' the limb is also 'anesthetic' and the nervous factor cannot operate." The results of our experiments indicate that the *anemic* limb is not entirely free of a blood supply. The moderate increase in weight with trauma suggests this. As to why most of these animals died, whether or not trauma was instituted and whether or not the knee jerks disappeared, we are unable to state. Some of the deaths were probably due to the anesthetic. It seems likely that the effective blood volume was probably decreased by the accumulation of blood in the posterior part of the body distal to the ligatures on the large blood vessels. If the reasoning of Slome and O'Shaughnessy is correct to the effect that "in the presence of such a complete 'ischemia,' the limb is also 'anesthetic' and the nervous factor cannot operate," some agency other than nervous impulses must be sought to explain the deaths.

Certainly, blood and fluid loss into and near the injured area is the most important initiating factor in the development of shock following trauma to an extremity of the anesthetized animal. After shock is fully developed, many other factors enter into its maintenance and progression. It has been shown (4) that a prolonged low blood pressure as a result of uncomplicated hemorrhage in unanesthetized animals is refractory to transfusion and results fatally. Freeman has shown that prolonged vasoconstriction produces at least part of the ill effects. Some investigators have ignored

periods were 36, 12, and 12 hours, an average of 20 hours. Nembutal was the anesthetic in the first 2 and chloralose in the last. The ligations were below the inferior mesenteric artery.

In animals in which the reflexes disappeared following the creation of the anemic limb, the effects of trauma were studied. Seven experiments were performed on cats, 4 being anesthetized with chloralose. Trauma as usual consisted of 20 blows with an iron bar, the femur being broken. The animals lived from 2 to 5 hours, an average of 4 hours. The difference in the weights of the traumatized and non traumatized extremities was small, less than 5 per cent of the body weight. A decrease in the concentration of the red blood cells was found in 2 of the 3 experiments in which it was determined. In 3 experiments, with nembutal as the anesthetic, the animals lived 4, 5, and 8 hours, an average of 5.7 hours following the trauma. All showed a moderate increase in the concentration of the red blood cells. The differences in the weights of the traumatized and non traumatized extremities were very small.

Control experiments without trauma were carried out on dogs. In 1 of the 3 performed under chloralose the aorta was occluded just below the renal arteries, and in 2 below the inferior mesenteric artery. The former animal lived 4 hours and the reflexes disappeared early. The animals with the lower ligations lived 11 and 19 hours, respectively. Reflexes disappeared in 1 and persisted in the other. An increase in the concentration of the red blood cells was found in all. In 3 dogs in which nembutal was used as the anesthetic, the aorta was occluded above the inferior mesenteric in 1 and below it in 2. The reflexes persisted in 1 of the 2 experiments in which the occlusion was below the inferior mesenteric. The animals lived 13, 16, and 16 hours, an average of 14.7 hours. A definite increase in concentration of the red blood cells occurred in 2 of the experiments.

In dogs in which the knee jerks disappeared following the anemic limb preparation trauma was applied. In 4 animals anesthetized with chloralose, the aorta was occluded below the inferior mesenteric artery in 3 and above it in 1. Following the disappearance of the re-

flexes, the leg was traumatized with approximately 40 blows with an iron bar and 15 blows with a hammer, the femur being broken. The animals lived 3, 4, 9, and 17 hours, respectively, an average of 8.2 hours. An increase in the concentration of the red blood cells occurred in 3 of the 4 experiments. The differences in the weights of the traumatized and non traumatized extremities were 0.87, 2.28, 1.8, and 1.43 per cent of the body weight, the traumatized extremity being heavier in each instance. Four experiments of the same type were done, with nembutal as the anesthetic. The occlusion of the aorta was above the inferior mesenteric artery in 1 and below it in 3, with the animals living 5, 14, 16, and 18 hours, respectively, following the traumatization, an average of 15.8 hours. A rather marked increase in the concentration of the red blood cells occurred in all. The differences in the weights of the traumatized and non traumatized extremities were .78, .77, 2.15 and .86 per cent of the body weight, the traumatized extremity was always heavier.

These results seem to indicate that the method of O'Shaughnessy and Slome does not render a limb completely anemic as evidenced by the increase in weight associated with trauma. Furthermore, the relatively short survival periods of some of the animals, particularly when chloralose was used as the anesthetic, would seem to question the value of the results of cross circulation experiments in which the anemic limb preparation is a necessary part.

#### EVALUATION OF STUDY—DISCUSSION

The preceding groups of experiments substantiate the views of O'Shaughnessy and Slome on the importance of the nervous factor in the production of shock following trauma to an extremity in only 1 respect, namely, that cats anesthetized by chloralose withstand trauma better if spinal anesthesia has been induced. This was not true in our experience with cats anesthetized with nembutal or with dogs anesthetized with chloralose. These latter findings held when the spinal anesthetic was administered after the shock had been induced as well as in those in which it was given before and at intervals following the trauma.

Transfusion plus spinal anesthesia was no more effective in treating this type of shock in dogs than transfusion alone. In cross-circulation experiments in which trauma was applied to a transfused hind limb of the recipient animal, no positive evidence as to deleterious effects of nervous impulses was obtained, confirming the findings of Bell, Clark, and Cuthbertson. The local loss of fluid in and near the injured area is the most important factor in the production of shock in anesthetized animals in which an extremity is traumatized. It is not maintained that this is the sole factor in the production and maintenance of this type of shock but that it is the most important one.

It has been emphasized that the mechanism of the production of all types of shock is not the same and all instances of shock cannot be explained satisfactorily by one theory. This paper deals only with the effects of trauma to an extremity of the anesthetized animal.

## REFERENCES

- 1 BELL, J R, CLARK, A M, and CUTHBERTSON, D P. Experimental traumatic shock *J Physiol*, 1938, 92 361
- 2 BLALOCK, ALFRED. Experimental shock *Arch Surg*, 1930, 20 959
- 3 Idem. Acute circulatory failure as exemplified by shock and hemorrhage *Surg, Gynec & Obst*, 1934, 58 551
- 4 Idem. Shock. Further studies with particular reference to the effects of hemorrhage *Arch Surg*, 1934, 29 837
- 5 CANNON, W B, and BAYLISS, W M. Note on muscle injury in relation to shock *Rep Shock Com, Med Research Com*, 1919, 26 19-23
- 6 DALL, SIR HENRY. Discussion on traumatic shock *Proc Roy Soc Med*, 1935, 28 1494
- 7 EDMUNDS and GUNN. Cushny's Pharmacology and Therapeutics P 253 Philadelphia Lea & Febiger, 1928
- 8 ELMAN, ROBERT, and COLE, W H. Loss of blood as a factor in death from acute portal obstruction *Proc. Soc Exper Biol & Med*, 1932, 29 1122
- 9 FREEDLANDER, S O, and LENHART, C H. Traumatic shock *Arch Surg*, 1932, 25 693
- 10 FREEMAN, H E. The effect of total sympathectomy on the occurrence of shock after hemorrhage *J Clin Invest*, 1938, 17 359
- 11 HARKINS, H N, and HARMON, P H. Plasma exudation. Loss of plasma-like fluid in various conditions resembling surgical shock *Ann Surg*, 1937, 106 1070
- 12 HOLT, R L, and MACDONALD, A D. Observations on experimental shock *British M J*, 1934, 1 1070
- 13 HOLT, R L. Discussion on traumatic shock *Proc Roy Soc Med*, 1935, 28 1473
- 14 JOHNSON, G S, and BLALOCK, A. Experimental shock IX. A study of the effects of the loss of whole blood, of blood plasma and of red blood cells *Arch Surg*, 1931, 22 626
- 15 O'SHAUGHNESSY, L, and SLOME, D. Etiology of traumatic shock *Brit J of Surg*, 1935, 22 589
- 16 PARSONS, E, and PHEMISTER, D B. Hemorrhage and shock in traumatized limbs *Surg, Gynec & Obst*, 1930, 51 196
- 17 SIMONART, A. Etude experimentale sur la toxémie traumatique et la toxémie des grands brûlures *Arch internat de pharmacol*, 1930, 37 269
- 18 SLOME, D, and O'SHAUGHNESSY, L. The nervous factor in traumatic shock *Brit J Surg*, 1938, 25 900
- 19 SOLLMAN, TORALD. Manual of Pharmacology p 754. Philadelphia W B Saunders Company, 1926
- 20 WOOD, and LAWALL. United States Dispensary 22d ed, p 1312 New York J B Lippincott Company, 1937

the part played by the loss of fluid other than whole blood. Freedlander and Lenhart state, "Rapid hemorrhage produced blood pressure curves similar in contour to those produced by trauma, however, with an equal loss of blood the end results were more severe following trauma. Further experiments showed that following trauma in addition to the loss of blood there was a considerable local loss of fluid due to edema. Therefore, the added loss of fluid could account for the more severe symptoms following trauma. This confirms the findings of Blalock." Harlins and Harmon have summarized the evidence on the effects of the loss of blood plasma.

Several interesting differences between dogs and cats were evident in these experiments. The reflexes under chloralose have been commented upon. Whereas, the red blood cells became more concentrated in a large percentage of the dogs which were traumatized a dilution usually occurred in the cat. Cats may survive after a longer period with a marked decline in blood pressure than is true with dogs. The difference in the weights of the traumatized and non traumatized extremities in percentage of body weight is usually greater in dogs in shock as a result of trauma than in cats. It is to be noted that the difference in the weights of the injured and non injured extremities in the dogs anesthetized by chloralose was not quite as great as that previously (4) found in dogs in which other anesthetics were used. Elman and Cole state, "We have observed death following the loss of 27 per cent of the body weight of a few control cats by simple bleeding from the femoral artery. The figure obtained by Johnson and Blalock in dogs was 5.1 per cent. The difference in the weights of the traumatized and non traumatized extremities of cats reported in this paper was usually greater than the figure for hemorrhage obtained by Elman and Cole.

It should be emphasized that this paper is concerned only with the results of trauma to an extremity of deeply anesthetized animals. From clinical experience, it seems very likely that nervous impulses do play a part in some instances in the production and maintenance of shock following injuries. The experimental proof of this in anesthetized animals is very

questionable. It seems very doubtful if nervous impulses play as important a rôle as is ascribed to them by O'Shaughnessy and Slome. The difficulty if not the impossibility of producing shock by repeated injuries to nerves alone is well known. It is our impression that one should be very hesitant in inducing spinal anesthesia in a patient in shock as a result of trauma. None of the animals, including the cats anesthetized by chloralose, appeared to be benefited by the induction of spinal anesthesia after shock was fully developed. Holt (13) stated recently, "In the same paper O'Shaughnessy and Slome have suggested that the induction of spinal anesthesia in an animal already in a severe state of shock results in a rise in the blood pressure. This has not been our experience. In fact in severe cases of shock it appears as though the induction of spinal anesthesia hastens the fatal result. It has certainly been my experience clinically that it is a most hazardous procedure to give a spinal anesthetic to a patient who is in a state of shock or dehydration without first of all carrying out measures to bolster up the blood volume."

In concluding, it should be emphasized that the mechanism of the production of all types of shock is not the same and all instances can not be explained satisfactorily by one theory. This paper deals only with the effects of trauma to an extremity of the anesthetized animal. It has been pointed out that definite conclusions cannot be drawn from these experiments as to the mechanism of the production of shock in man.

#### SUMMARY

Many experiments were performed on anesthetized animals in which shock was produced by repeated blows to a thigh. The only positive evidence as to the importance of nervous impulses in its genesis was obtained in experiments on cats anesthetized by chloralose in which a preliminary and repeated spinal anesthetic apparently exerted beneficial effects. This was not found in cats anesthetized by nembutal or in dogs anesthetized by chloralose. Neither was it found in cats anesthetized by chloralose in which the novocain was not given until after shock had developed.

for it is quite possible for jaundice to become manifest in the presence of an external biliary fistula. The jaundice usually comes on, however, in from 3 to 6 months after the operation and, in a typical case, is painless in character and gradual in its onset. But there must be a wide range in the time necessary for the bile duct to become so small that all the bile cannot get through; and it is probably fair to conclude that if a patient, following a cholecystectomy, has had a normal convalescence and has remained well for a period of 2 years, any subsequent disease in the biliary ducts cannot properly be ascribed to the operation. As Carter points out, the inflammatory reaction most likely was there in an insipient stage at the time of the cholecystectomy.

Strictures which are the result of operative trauma, like those occasionally seen following ulceration about a stone, are usually local in character, while those caused by a chronic inflammatory process generally involve a considerable portion of a duct. In contradistinction to this local inflammatory lesion is the condition in which all the extrahepatic ducts are the seat of an obliterative cholangitis, and as this disease is exceedingly rare I am taking this opportunity to report a case which recently came under my observation.

Mr. K. B. H., 42 years of age, while in a mining camp in Northern Ontario in the spring of 1937, suffered an attack of what was described as dysentery which confined him to bed for 3 weeks. Some 4 months later he noticed that his skin was becoming yellow but otherwise he felt quite well, in fact, he exposed his body to the sun to hide the discoloration from his friends. During the early part of October he was in the hospital 1 week for observation and investigation and, except for the jaundice, the findings were largely negative. The liver edge could not be palpated and the stools, while not normal always, gave a positive reaction for bile. There was no elevation of temperature or pulse rate and no leucocytosis. The van den Bergh test on admission showed 52 milligrams per 1000 cubic centimeters of blood and as the jaundice was definitely fading on discharge it was thought that his was a case of infectious jaundice. During the first week in November the patient noticed that the jaundice was getting worse and he was admitted to St. Michael's Hospital on November 19, 1937, under the care of Dr. Harold Armstrong of our staff. At that time he was quite deeply jaundiced, the urine very dark, and the stools clay colored. There was, however, no enlargement of the liver and the gall bladder could not be pal-

pated. Again there was no history of pain and the temperature and pulse were normal. Exploration was decided upon and in preparation he was given calcium chloride and glucose.

At the operation, which was performed on November 24, the gall bladder was found to be normal and free from stones, but the common bile duct was about one quarter its normal size and felt like a fibrous cord. On incising it in a longitudinal direction only about a dram of pale bile came away. The wall was very thick and its lumen would barely admit a No. 4 ureteral catheter, and when the common hepatic and right and left hepatic ducts were examined, they were found to be in a similar condition. An attempt was made to drain the biliary system with a ureteral catheter but the patient went down hill steadily. Two days after the operation he ejected a rusty sputum, and this was followed a few days later by a severe secondary hemorrhage which required a transfusion. Very little bile was ever secreted and the operation site became filled with blood clots. He died of cholemia on December 7.

A somewhat similar case was reported recently by Phillips and Kilgore except that in their patient only the common hepatic and right and left hepatic ducts were involved. But their description of the findings is misleading, as the heading refers to the common bile duct so that all 3 may have been involved. No operation was performed because of the precarious condition of the patient. The diagnosis was made at the autopsy. Like the congenital variety, this is a most distressing type of obstruction and one for which little or nothing can be done.

#### METHODS OF TREATMENT

Many methods of dealing with a benign stricture of the bile ducts are in vogue but each stricture is an individual problem and the operator must decide upon the best procedure to adopt after a careful examination of the lesion and having in mind his own capabilities. Provided, as is usual, that the gall bladder has been removed and is therefore of no help, an end-to-end suture over a T-tube or some modification of this is best, but it is often not feasible because of the extent of the stricture, since, to be successful, there must be no tension on the suture line. Failing this the W. J. Mayo operation of anastomosing the divided duct to the duodenum is best, although because of the liability to stricture formation in the end-to-end suture, this by some is

# BENIGN STRICTURES OF THE BILE DUCTS WITH A NEW METHOD OF TREATMENT

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**B**ENIGN strictures of the bile ducts are among the less common causes of obstructive jaundice, but they constitute the most difficult problems in gall bladder disease which surgeons are called upon to treat, for unless the flow of bile is directed freely into the intestinal tract the patient has nothing to look forward to but a miserable existence ending eventually in death.

## CAUSES OF STRICTURES

In addition to the congenital variety, which is fortunately rare, there are 3 causes of benign strictures of the bile ducts: injury to either the common hepatic or common bile duct at the time of the cholecystectomy, ulceration with subsequent cicatrization about a stone in the duct, or inflammation in the ducts quite apart from the presence of a stone.

Injury at a previous operation, however, is by far the most common cause. Walters, at a staff meeting of the Mayo Clinic, reported 51 operations for stricture of the bile ducts and draws attention to the fact that in every instance there had been a previous operation upon the biliary tract, all but 3 having had a cholecystectomy. Lahey, who at the time of his paper on strictures of the common and hepatic ducts had operated upon 37 patients, expresses the same opinion. There are several ways in which the ducts may be injured and these are well exemplified in Lahey's article. The only safeguard, however, is visualization of both the common hepatic and common bile ducts before either the cystic duct or artery is tied, having in mind various abnormalities, especially the presence of a long cystic duct which is adherent to the common hepatic duct for an inch or so before joining with that structure to form the common bile duct. Recently, in operating upon the biliary tract, I

found the hepatic artery crossing in front of the entrance of the cystic duct and then continuing on into the hilus on the right side of the common hepatic duct, where for a time it was thought to be the duct, so it behooves the surgeon always to take a second look and be sure.

But, while it is true that the great majority of benign strictures are the result of faulty technique in removing a gall bladder, the surgeon is not always to blame. Aynesworth reports the case of a woman whose gall bladder was removed 2 months after a cholecystostomy and the patient remained well for 7 years. She then returned with all the signs of an obstructed common duct which at operation was found to involve about an inch of the proximal portion of the common bile duct. Certainly in this instance the cholecystectomy cannot have been the cause which must be attributed to cholangitis. There are many instances in the literature of the stricture developing or at least showing itself 2 or 3 years following the removal of the gall bladder. In fact, Judd was strongly of the opinion that an obliterative cholangitis was responsible in a large number of cases. Be this as it may there is one infallible sign that the operator has been at fault, that is the prolonged drainage of bile from the operative wound, a complication which was a marked feature of the case which I am to report.

The history of difficulty in controlling hemorrhage from the cystic artery, as pointed out by Lahey, is also of the greatest significance, and hurried attempts to secure the bleeding vessel without first obtaining a dry field are responsible for the many instances in which the common hepatic duct is injured. The time of the onset of the jaundice depends upon the extent of the injury to the duct, upon the consistency of the bile, whether thick or thin, and whether or not all the bile is being discharged through the abdominal wall,

Then again, instead of acting as a channel the tube may actually be obstructing the flow of bile, as shown by the prompt relief sometimes seen following the evacuation of the tube which may even be vomited. There are recorded instances of a tube causing intestinal obstruction and Roeder, apparently in a personal communication to Eliot, refers to a case in which a long tube in a biliary fistula implantation perforated the sigmoid causing a fatal peritonitis 3 months after insertion. Most surgeons then would probably agree with Lahey that this method is at best only a makeshift

Another way in which these difficult strictures may be treated is by the Wilms-Sullivan method. This consists of inserting a tube of suitable size into the proximal part of the duct and the distal end into the duodenum and then covering the exposed portion of the tube with omentum. Ellsworth Eliot, Jr., whose remarkable contributions to the subject of benign strictures of the bile ducts are of outstanding merit, and from which I have drawn freely in preparing this paper, has with commendable zeal and energy collected 38 cases in which this type of repair was employed. Thirty-five of these are reported in his 1936 article, together with 3 others, those of Brewer, Terrier and Propping which were omitted from his collection in *SURGERY, GYNECOLOGY AND OBSTETRICS*, published in January, 1918.

An analysis of these cases is most instructive. Of the total, 5 are reported by Wilms and his associate Brandt and there was no mortality, but in none was the elapsed time sufficient to properly appraise the result. Two of the patients developed a duodenal fistula, 1 so severe as to require a jejunostomy and the other required a second operation for its relief. In a third case the operation had to be repeated. Jenckel has had the best results from this method. He has had 10 operations to his credit with only 2 deaths, 1 of which, however, did not occur until 12 years later and from the description death in this instance was undoubtedly caused by a liver ailment. Altogether there were 11 deaths or a mortality rate of approximately 29 per cent.

If Wilms' and Jenckel's cases are omitted, which would give a more accurate cross section of the death rate from this operation, the mortality rate approximates 39 per cent. In many of the reported cases important details are lacking but recurrence of the stricture is common together with cholangitis, biliary and duodenal fistulas, and abscess of the liver. In this connection it is interesting to note, as emphasized recently by Sandblom, Bergh and Ivy, that following any abnormal channel between the biliary and intestinal tract hepatitis and liver abscesses are of frequent occurrence, and, peculiarly enough, they give little clinical evidence of their presence and are discovered only at autopsy. But it is not in the nature of things for surgeons to be eager to report their failures, so there must be a considerable number which are not recorded. It would appear, however, that sufficient evidence has been collected to show that the Wilms-Sullivan operation leaves much to be desired.

Another method by which these difficult strictures can be treated is to allow a biliary fistula to form, wait 3 or 4 months and then cone out this track and implant it into some portion of the gastro-intestinal tract. The operation, however, is by no means a simple one for, unless an adequate blood supply is provided, the fistulous track will die, and even if this difficulty is overcome, undue tension will have the same effect so that it is not to be wondered at if failures are frequent occurrences.

Again we are indebted to Eliot for his collection of 41 cases, the majority of which are from surgeons in this country. In 22 the implantation was into the duodenum, in 18 into the stomach, and 1 into the jejunum. Here, too, some of the reported cases were too recent to evaluate the result, but there were 18 in which death could be attributed to the operation making a mortality rate of about 45 per cent. Hemorrhage, shock, and hepatic insufficiency account for many of the early deaths, but if the patient survives the operation there are many complications which may supervene. Nine of these patients are reported to have developed strictures and in one instance this occurred a second time, so that



considered the operation of choice. Provided the stricture is below the entrance of the cystic duct, this is not a particularly difficult procedure to one accustomed to gall bladder surgery, but to the inexperienced it may be a hazardous operation especially as is the case when a long and tedious dissection is necessary before the exact condition of the ducts is demonstrated. But if the stricture extends high up in the common hepatic duct, it may be quite impossible or even highly dangerous, particularly in a fat subject or when dense adhesions prevent the duodenum from being mobilized sufficiently to permit accurate anastomosis without tension. It is to benign strictures of this kind in which neither end to end suture nor some form of direct anastomosis between the dilated duct and the gastro intestinal tract is feasible, that I wish particularly to direct attention in this paper.

Several methods, many of them very ingenious, have been employed in an attempt to establish a connection with the intestinal tract. One plan is to incise the stricture throughout its length and, after making sure that the distal portion of the duct is open to the duodenum, to connect the two ends with a rubber tube of suitable size and length and to suture the adjacent tissues snugly over it. Some prefer that the tube be passed through the ampulla into the duodenum, while others advise that it should stop short of the bowel. If it is the intention to have the tube remain *in situ* or to remove it once it has served its purpose, it should not pass through the ampulla, for there is abundant evidence as shown by Sandblom, Bergh, and Ivy, that the danger of infection spreading up the duct is increased by any interference with the function of the sphincter of Oddi. And under such circumstances there is danger not only of a biliary fistula but, what is much more important, a duodenal fistula as well. But passing a tube through the ampulla of Vater is by no means the simple procedure which a perusal of the literature would lead one to suppose. It may in fact be quite a difficult feat and, if the inside of the duodenum were examined in every instance, not a few would be found to have entered by a false passage as may be verified by a perusal of autopsy findings. Of

course, if the ampulla can once be entered for sure by some form of bougie, dilatation to the requisite size is readily accomplished, but in a small percentage of cases there is always a reasonable doubt about where the instrument has gone.

Leaving a rubber tube in a bile duct has many disadvantages and, as Lahey contends, is at best nothing more than a makeshift. It may pass too quickly before time has been afforded for reconstruction of the channel, and to obviate this difficulty McArthur puts a reverse cuff on the end of the tube. On the other hand, it may remain too long, for it is probably true that if it does not pass it will sooner or later give rise to trouble. Naturally, the more normal the bile flow is in consistency the longer will the symptom free period be, but incrustations both within and without the tube are almost inevitable and they may actually block the flow of bile. Colp, however, states that many tubes which have apparently been in the ducts for almost a year show very little deposit of bile salts, and he is most insistent that the greatest care be exercised in selecting the best and highest grade of rubber and, if possible, a variety that is opaque to the x rays. Judd removed a calcified tube in one case 4 years and in another 6 years after its insertion, the patient in each instance suffering from a severe attack of cholangitis. But Lahey, in the excellent article already referred to, treated one of the strictures by this method and made reference to removing a tube, for what he does not say, which had functioned well for 7 years and which he replaced by another.

But there are other objections to the indwelling tube, whether its distal end projects into the duodenum or not. It may become displaced upward so as to lie in the hilus of the liver, as in a case recently reported by Robert L. Payne. When used in an end to end suture, the tube has been known to become angulated at the suture line with the production of a biliary fistula, and to obviate this, Voelcker advocated bringing the tube out through the duodenum by the Witzel method, but this merely substitutes the danger of a duodenal fistula for the biliary one, although in a reported case the result was most gratifying.

The new method which I wish to record is in reality a very simple procedure and consists essentially of making a new bile channel out of the wall of the stomach but without opening it. The exposure of the ducts, a tedious, difficult, and dangerous procedure at all times, is made in the ordinary way. If the operator decides that an end-to-end suture is impossible or an anastomosis of the proximal end to the duodenum is not feasible, one proceeds as follows: After isolating the dilated portion of duct which will likely be found high up in the hilus of the liver, and making sure of its identity by aspiration with a hypodermic needle, the operator slits it sufficiently wide to admit a tube about the size of a No 20 French catheter which is immediately inserted and the opening closed tightly around it by a suture. The tube is then placed upon the anterior surface of the stomach commencing just proximal to the pylorus and buried for a distance of 2 inches in its wall by oversewing with a running stitch of catgut. Omentum is then tucked about the exposed portion of the tube that lies between the bile duct and the stomach after which the free end of the tube is brought out through the upper portion of the abdominal incision, where it is securely fastened by a silkworm stitch and the abdomen closed (Fig. 1).

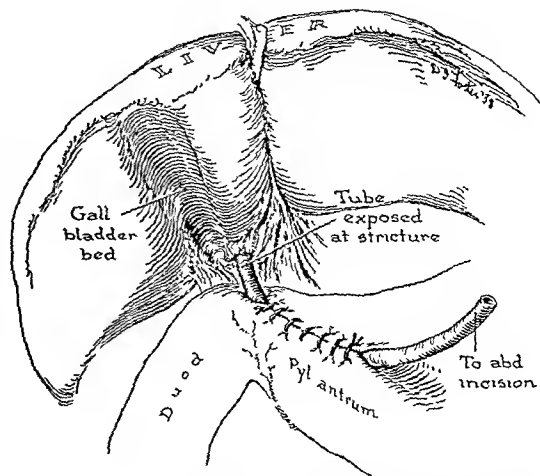


Fig 1 Diagram showing tube entering the bile duct, bridging the gap to the region of the antrum where it is embedded by the Witzel method and then on to the abdominal incision

Our original conception was to withdraw the tube in about 3 months when it was thought a new channel would be well established. It would then be a simple matter to insert an internal urethrotomy knife the requisite distance, cut through the wall and produce an internal fistula, but to our surprise nature, apparently by a process of ulceration, had accomplished this for us. Following this the external opening promptly closed.

CASE 1. Mrs. M., 26 years of age, having suffered repeated attacks of colic with jaundice, was operated upon by another surgeon on September 21, 1932. The gall bladder containing 1 moderately large stone was removed and, although the common bile duct was not dilated and there was no jaundice at the time, the ducts were examined by passing a lead probe through the stump of the cystic duct split to admit the probe. The probe is said to have entered the duodenum and no stones were found. The next day there was a profuse flow of bile mixed with blood from the wound and this was the precursor to a very stormy time. The bile continued to

be discharged from the surface and by the middle of October the stools were clay colored. In spite of the external biliary fistula she commenced to get jaundiced about the middle of November and by the end of the month it was very marked. On December 3, 1932, I operated upon her hoping to find a stone, but after a tedious dissection no trace whatever could be found of the common bile duct, and the stump of the common hepatic duct appeared as a grape-like projection in the hilus of the liver. One limb of a T-tube was placed in the duct and the other into the duodenum while the stem together with a Penrose drain was brought out through the abdominal incision. In a few days, although the stools were bile stained, she developed a very severe type of duodenal fistula so that very soon much of the food she consumed together with a large quantity of bile was discharged through the wound and she lost weight quite rapidly. She went through a very trying period but after a couple of months she commenced to pick up and she was discharged on March 3, 1933, with the T-tube still in place. She had no jaundice at this time but there was still a small quantity of duodenal content coming away alongside of the T-tube. She enjoyed tolerable health until August when she began to have frequent attacks of pain and jaundice so the T-tube was removed. No improvement followed and by the end of October the external fistula had closed. On December 14, 1933, she was re-admitted at which time she was deeply jaundiced with clay colored stools and very much underweight. On December 20 I operated on her again and after a most difficult dissection isolated the proximal portion of the duct and performed the operation described. Her convalescence was quiet and uneventful. Bile discharged freely from the tube and the jaundice rapidly cleared. She was discharged on February

in these cases another and obviously much more difficult operation had to be performed in order to relieve the individuals of this distress. Lahey has operated on 14 patients by this method, 7 of which are recorded in Eliot's list, and concludes that in only 2 instances was there permanent benefit, most of the survivors having fared badly because of contraction of the fistulous track. One of his patients, however, was well 15 years after the operation. But Walters, who has performed this operation 9 times, 7 of which are in Eliot's list, expressed the opinion that it continues to be a useful procedure. One of his patients was symptom free 9 years after the operation.

According to personal communications to Eliot, the German surgeons also were having trouble with the direct method of implantation. Hildebrand in an attempt to obviate the bad results divided the upper jejunum and, after re-establishing the continuity of the intestinal tract, brought the distal end out through the abdominal wall for anastomosis to the opening on the skin of the biliary fistula. His patient died, however, 5 years later with deep jaundice and a subhepatic abscess. Other German surgeons modified this procedure but with no better result. Nevertheless, in spite of the few brilliant results which have been obtained by direct implantation of the fistulous track, it must be obvious to all that any operative measure, which in the hands of experts carries such a high mortality, must be undertaken with a considerable amount of misgiving. Most surgeons would probably agree with the statement of Vincent, as quoted by Eliot, that a partial result which begets cirrhosis is not worth while.

Another way in which these difficult types of stricture have been dealt with is by direct anastomosis of the liver substance to some portion of the intestinal tract usually the duodenum. This operation is known as hepato enterostomy. Eliot has succeeded in collecting 11 cases all from German sources and mostly by personal communication, but as far as I can learn there is no report of a similar procedure having been done in this country. It is performed by puncturing the liver with the actual cautery in an attempt to

establish a biliary fistula, and subsequently dissecting this out and implanting it into some portion of the intestinal tract, or the punctured liver may be immediately anastomosed to the intestine. That bile may flow quite freely from a liver fistula is attested to by many authors. I recall a jaundiced patient in whom a copious discharge, which lasted for nearly 4 weeks, followed the incision of a necrotic area in the left lobe of the liver. It had, however, very little effect upon the icteric index and eventually closed leaving the patient no better off than before. Granulation tissue encroaches more and more upon the lumen and though it may be kept open for a while by curetting, the tissue usually wins out in the end. Enderlen's patient, who was alive and well 11 years afterward, is as surely a brilliant result, but Enderlen also reports a second case in which the same technique was used, following the failure of a previous hepatoduodenostomy, and the patient died about a week postoperatively. At the autopsy the original anastomotic opening was found to be completely obliterated. But in Lameris' patient, who died 8 months after the operation from multiple abscesses of the liver, there were 10 small openings in the liver at the anastomotic site from which bile could be expressed. Undoubtedly there is a considerable variation in the distribution of the large bile ducts within the liver.

Any considerable discharge of bile from the liver in doing a cholecystectomy is unusual, but some years ago I opened up a bile duct fully a nighth of an inch in diameter about  $1\frac{1}{2}$  inches from the anterior border of the liver, and so freely did bile flow that it was thought at first to be coming from an injury to one of the main ducts. For 2 weeks the discharge of bile was fairly free after which it gradually ceased and the wound was closed within a month. It would appear then that there is a considerable element of luck in selecting the area of liver to be joined to the bowel. It does not, however, strike one as a feasible way in which the bile may be successfully drained into the intestinal tract, and the fact that it has not been taken up by any surgeon in this country is probably sufficient to indicate that it has little to recommend it.

# CANCER OF THE STOMACH

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WE may find cause for satisfaction in the general advance of surgery during the last decade, but upon the subject of cancer of the stomach we can look only with gloom. It is the commonest of all cancers, and though its incidence varies in different countries, it, nevertheless, occupies this unenviable predominance. The operability in cases of patients presenting themselves with symptoms is lower than with any other growth. The operative mortality remains much as it was 30 years ago and is the highest of any major operation. The cure rate among those that survive is the lowest in cancer surgery. Yet no alternative treatment that might relieve us of this depressing and almost hopeless task has appeared on the scene. I have chosen to present this unsatisfactory subject because I consider that in endeavoring to set our house in order we ought to pass by its beautiful chambers, many of them recently renovated and re-decorated in the latest style, and turn our attention to the dreary basements. I shall make suggestions as to how we should set about this task, but I shall not present my own figures, which are too few to be impressive and too true to be good. I may, however, illustrate the position today by a simple diagram, constructed from the figures of many surgeons of experience and repute (Fig. 1).

Gastric cancer thus presents a four-fold problem for attack. It is the commonest and least operable of all growths, and its treatment by surgery has the highest death rate and the lowest cure rate. If any of these aspects can be tackled successfully, we shall be doing something to better the present position; and they can all be tackled. We know that the disease is commoner in certain countries, in certain areas in those countries (Fig. 2), and in those areas it is seen most often in men of certain occupations. It should not be beyond the power of statisticians to trace

the factors that are responsible for this incidence, or of public health authorities to eliminate them.

The low operability rate is a reflection upon our diagnosis. Many sufferers from cancer of the stomach have no warning beyond an indefinable loss of strength till nearly the whole organ is involved; but on the other hand many of those who arrive, to our chagrin, far too late, have suffered from digestive discomfort for months or even for a year or 2, and have had recourse to diet and alkalis before finally coming to their physician for an overhauling. Should we not write up in neon lights in every restaurant, "Indigestion does not start after 40 in a man who has been able to eat anything till then." Should we not even put a more discreet notice in the office of our medical colleagues, "Gastric ulcer does not present itself for the first time after 40." Both statements are obviously open to exceptions. But if we make it a rule that every case of indigestion, starting in middle life, be immediately investigated to eliminate cancer before any treatment is undertaken, and if we label every gastric ulcer first appearing after 40 as malignant, until unequivocal appearance in the gastroscope, or rapid disappearance of the deformity in the roentgenogram and of occult blood from the feces have shown it to be innocent, we shall immediately bring a large number of patients from the hopeless into the hopeful category. It is, however, with the last two aspects, the high death rate and the low cure rate that we, as surgeons, are particularly concerned.

To discuss mortality implies setting a figure, just as to discuss a golfer's handicap implies fixing bogey for the course. Among good surgeons I would put the hospital death rate between 20 and 30 per cent after operations for cancer of the stomach. I am aware that figures of 10 per cent and under have been recorded, but knowing what I do of the limits of technical skill, I cannot believe that they all refer to the same thing. A few gastric

11, 1934, with instructions to keep in touch with our outdoor department. In my absence arrangements were made on March 22 to produce an internal fistula but after a few whiffs of ether she vomited up bile and the operation was not proceeded with as it was obvious an internal fistula had already been established. Following this no bile or stomach content came from the abdominal wound and the opening was closed in 2 weeks. She has never had an attack of jaundice since and when seen recently looked in perfect health having gained 40 pounds.

One of the great advantages of the operation herein recorded is that it is a simple procedure and one that may be quickly carried out. Most patients by the time the ducts have been clearly visualized, are in no condition to undergo any further difficult procedure hence the advice of some surgeons to permit the formation of a biliary fistula and do a second operation later. Since the stomach is not opened at the time there is no possibility of peritonitis or a dangerous fistula. Obviously, a single case in which the patient has been well for nearly 5 years is not sufficient to permit one to make extravagant claims, and stricture and cholangitis, the bugbears of bile duct surgery, may yet supervene unless per chance the endothelial cells from the peritoneal coat of the stomach be more effective in producing a protective lining than the epithelium has been in some other types of reconstruction. But complications will probably occur even after most successful reconstructions of the ducts if there is a sufficiently long survival and a proper follow up is instituted.

#### CONCLUSIONS

Most benign strictures of the bile ducts follow a cholecystectomy and an unexpected flow of bile from the wound a day or so after ward or a stormy convalescence is very significant.

Diffuse narrowing of the ducts is a rare variety and a case is recorded.

End to end suture or direct anastomosis of the duct to the duodenum is the operation of choice when this can be accomplished without tension.

The difficult cases, however, are those in which these methods are impossible and it is with this type that the paper largely deals.

The disadvantages and difficulties of reconstruction over a buried rubber tube are outlined. The Wilms-Sullivan operation and the implantation of the biliary fistula into the gastro-intestinal tract are shown to be unsatisfactory and accompanied by a very high mortality. Direct anastomosis of the liver substance to the bowel is a method which has been used by continental surgeons only and is not to be recommended.

A new method which is simple and safe for dealing with these difficult strictures is recorded and details of a successful case are given.

#### BIBLIOGRAPHY

1. AYNESWORTH E. H. Stricture of the common bile duct. 1935 27 562-563.
2. CARTER R. FRANKLYN. Benign fibrous stenosis of the common duct. *Am J Surg* 1935 30 110.
3. COLP R. Biliary duodenal intubation. *Surg Gynec & Obst* 1936 63 157.
4. ELIOT ELLSWORTH JR. Benign cicatricial strictures of the bile ducts. *Ann Surg* 1936 104 668.
5. JOHN C. S. Stricture of common bile duct. *Ann Surg* 1926 84 404-410.
6. LAHEY F. H. Strictures of the common and hepatic ducts. *Ann Surg* 1937 105 763-790.
7. McARTHUR L. L. Repair of the common bile duct. *Ann Surg* 1925 88 120-138.
8. PAYNE ROBERT L. Discussion of paper by Drs. Heuser and Lahey. *Ann Surg* 1937 105 780.
9. PHILLIPS J. R. and LILGORE F. H. Primary inflammatory stricture of the common bile duct. *Am J Surg* 1935 27 545.
10. ROEDER C. A. *Ann Surg* 1930 91 144 147.
11. SANDBLUM P. BERGH G. S. and ILY A. C. Cholecystoduodenostomy combined with pyloric exclusion. *Ann Surg* 1936 104 62-710.
12. VOELCKER F. Beitr z Klin Chir 1911 Vol 12 p 581.
13. WALTERS W. Strictures of the bile ducts. Results in 51 operative cases. *Proc Staff Meet Mayo Clin* 1917 12 25-30.

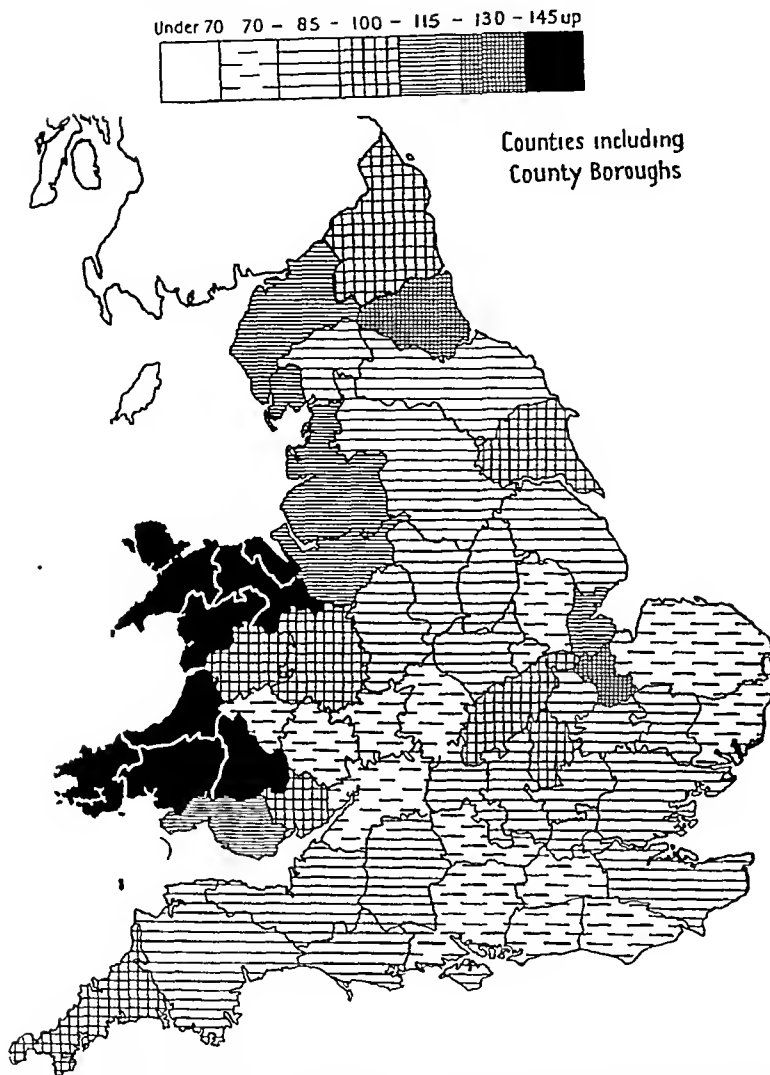


Fig 2 The regional incidence of cancer of the stomach in the British Isles, as judged from the returns of the Registrar General (Reproduced by kind permission of the British Empire Cancer Campaign)

successful in some 250 gastric resections, and that the number in which it has had to be supplemented by gas is only about a dozen.

Premedication is necessary because no normal person can lie still for 1 to 2 hours on a narrow and rigid table unless so prepared. Basal narcotics are unsatisfactory for this purpose, for they make the patient a reflex animal bereft of higher control, and he responds to all stimuli by movement. After

many experiments I have adopted the use of omnupon two-thirds of a grain 1 hour before operation. Two adjuvant drugs should be avoided: atropine, because the thirst it induces makes the patient restless, and hyoscine because, though it quiets some patients, it makes others silly drunk and quite uncontrollable. After the omnupon is given, the patient's ears are plugged with wool and his eyes covered. He is brought to the theater

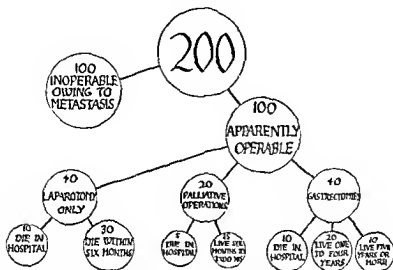


Fig. 1 The fate of 200 cases of cancer of the stomach presenting themselves at hospital

ulcers slipped in by a lenient pathologist will do wonders for any series.

In the hands of expert surgeons, patients do not die of gastrectomy. Shock has been abolished and hemorrhage does not occur. Speed without haste and neatness without fuss ensure that patients leave the table little the worse for their ordeal. But patients die after gastrectomy because those with cancer of the stomach are old, enfeebled, and liable to die at any time so that they often succumb while they are in the hospital for investigation or are undergoing palliative treatment. Nevertheless, we must remember that in the operation for cancer of the stomach we are working pretty near the limits of human endurance, and if we are to improve our late results we must push right up to those limits. Whatever of speed, dexterity, and gentleness we have learned from the great masters like Halsted and Moynihan we must put into practice.

To those technical details I would add one further that to my mind is essential, the use of local anesthesia. However good a surgeon's mortality may be it will be better if he adopt this method. Local anesthesia will make the operation easier for the surgeon, and this leads to neater and quicker work, but it also removes all need for hurry, should extra time be wanted for some refinement. Relaxa-

tion is perfect, respiratory movements are slow and shallow, the blood pressure is not raised nor the capillaries dilated, and the viscera preserve their tone and movement and do not prolapse from the wound. It abolishes many of the risks of the postoperative period. The patient is conscious and rational, unlike the subject of spinal anesthesia, he can sit up, he can breathe, move, and drink, so that the likelihood of respiratory, vascular, and embolic complications is greatly diminished. Further he has inhaled no foreign vapor or gas, so that he will not secrete respiratory mucus in excess. These advantages continue over the later stages of recovery, for the solution employed, introduced by Crile for anoxia association is anesthetic for 4 hours at any rate and diminishes painful sensations for several days, tiding over the patient to the stage of repair. The inhibition of a painful wound is avoided.

I hesitate to describe my methods, knowing that the use of local anesthesia is associated above all with the name of Hans Finsterer, to whom I owe more than I can say. But since I had the opportunity of seeing him do only 2 cases, and used the method 7 years before and 6 years since that time, I cannot say how far my present technique corresponds to his. I can only say that it has proved entirely

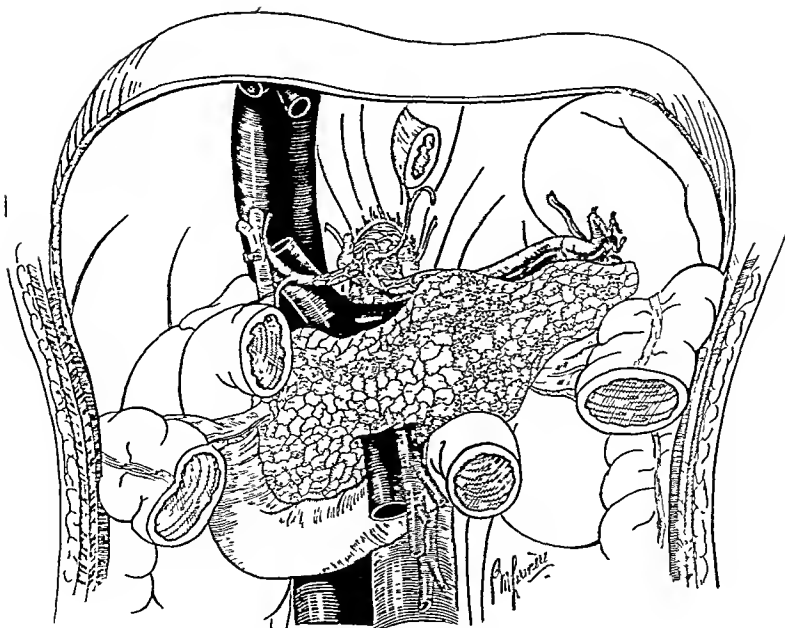


Fig 6. Relations of the splanchnic plexus

Five wheals are necessary, 1 just below the xiphisternum, and 2 each side of the outer border of the rectus in the subcostal and inter-spinous planes (Fig. 3). A very fine needle is used, and after each wheal is made the needle is pushed on into the rectus sheath in several places by sliding the skin, injecting a few cubic centimeters in each, so that sheath and muscle are made insensitive to the larger needle that follows. The whole operation should be painless except for the first 5 pricks.

The next step is to inject the subcutaneous tissues in a fan over the xiphisternum and lower costal cartilages. This area is not insensitized by a rectus sheath block, yet it adjoins the upper end of the incision and may easily be touched by a sharp instrument. An injection of 15 cubic centimeters of one-half per cent solution is used for this. From the same central wheal an injection of 5 cubic centimeters is put into the rectus sheath on each side of the xiphisternum.

A continuous puddle of one-half per cent solution is now laid along the costal margin and outer border of the rectus, to infiltrate the nerves where they lie as single trunks in an aponeurotic compartment. The solution

is injected through the 2 lateral wheals into a sheath already anesthetized, and is distributed as evenly as possible, about 5 cubic centimeters to the inch, or 70 cubic centimeters each side. The operator washes up again, putting on his gown and gloves, and returns to find everything ready, and the patient probably asleep.

After the peritoneum has been opened, the wound edges are held up by an assistant, and further injections of one-half per cent solution, or 20 cubic centimeters on each side, are made from within, chiefly into the diaphragmatic peritoneum and the right and left paracolic gutters (Fig 4). These are areas that have not been anesthetized by the rectus sheath block. A broad and deep retractor is then slipped under the liver and held back by an assistant, while the surgeon places his right hand, palm downward, on the stomach and slips the tips of his fingers down the retractor till they rest on the aorta (Fig 5). The middle finger identifies the aorta above the celiac axis trunk by the fact that no pancreas intervenes, and then pushes it to the left, increasing the normal space of about half an inch between the aorta and vena cava to 1 inch. The splanchnic injection is made into



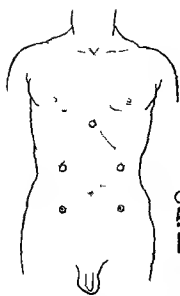


Fig 3

Fig 3 Local anesthesia of the abdominal wall (1) cutaneous wheals (2) subcutaneous injections, (3) deep injections

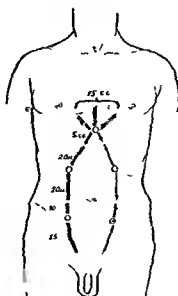


Fig 4

Fig 4 Supplementary injections into the abdominal parietes from within

some minutes before the surgeon is ready, and encouraged to doze off on the table

The anesthetic solution is made in two strengths (1) novocain, one half per cent, quinine and urea hydrochloride, one fourth per cent, Ringer's solution to 400 cubic centimeters, (2) novocain, one per cent, quinine and urea hydrochloride, one fourth per cent, Ringer's solution to 60 cubic centimeters To

each solution 1 drop of adrenalin for every 10 cubic centimeters is added just before use

I use the Labat 10 cubic centimeter syringe, 2 of which are alternately handed to me, filled by the assistant. Regional block is not tissue infiltration but measured dosage at certain anatomical points, and with pressure apparatus or self feeding syringes this ideal is lost sight of. I regard it as important that no local anesthetic be injected into any tissue that is going to be cut or handled, if this can be avoided, so that the whole operation, dissection and subsequent suture, takes place as far as possible in normal tissues. For this reason I have abandoned infiltration of the line of incision

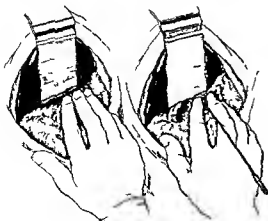


Fig 5 Injection of the splanchnic plexus

Injection is done before gown or gloves are put on 2 temporary sterile towels being put above and below the operative field. This plan enforces a delay of 5 minutes while the surgeon is dressing up, which allows the patient to settle down to sleep, gives the local anesthetic time to take effect and affords the nurse and assistant an unhurried interval to repaint the abdomen, drape the field, and rehearse every detail of instruments and material before the operation starts

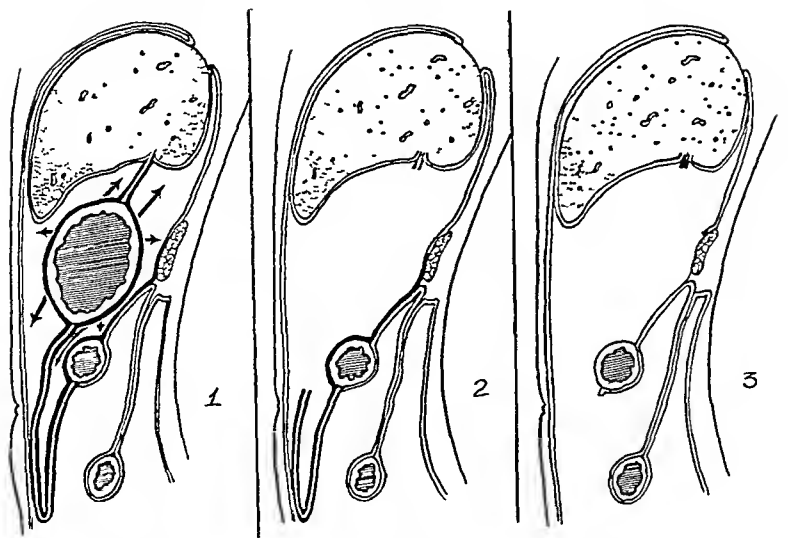


Fig 9 The peritoneal compartments in relation to cancer spread 1 Celomic transplantation of gastric cancer, 2, amount of cancer bed removed in standard gastrectomy, 3, amount removed in radical gastrectomy

it is not often that the otherwise early and operable case is taken out of that category on these grounds

The sinister features of cancer of the stomach are its wide and early dissemination by lymphatic channels, and its tendency to shed cells that graft themselves on the peritoneum, usually on the omentum or in the pelvis. The cases that seem from their histories to be early and from the skiagrams to be localized but prove on laparotomy to be inoperable, are usually hopeless because of wide dissemination in lymphatic channels or distant peritoneal deposits. Those that recur after an apparently adequate resection do so either in the upper part of the stomach and the glands round the celiac axis, or in distant parts of the celomic cavity. Such recurrences are, of course, the development of extensions that were present but imperceptible at the time of operation, for cancer never recurs. We have here a problem with which we, as surgeons, can rightly concern ourselves while we are waiting for our medical friends to send us earlier cases, and that is the extending of our operation as far as is technically possible to embrace the whole area in which malignant cells are likely to lie in the early and apparently operable cases of gastric cancer.

We cannot, by any means within the compass of practical surgery, remove all seedlings of cancer that may have been cast into the peritoneal cavity. But the earlier free cells, if shed from the anterior surface of the stomach, are likely to lie in that part of the cavity bounded by the anterior abdominal wall in front, and the great omentum behind, and if arising from the posterior surface of the stomach, they will drop into the lesser sac, bounded to a large extent by the omentum and transverse mesocolon (Fig. 9, 1). Removal of the whole great omentum with the stomach, by detaching it from the colon and following this plane down the superior leaf of the transverse mesocolon to the posterior abdominal wall, will remove about 75 per cent of this potential cancer bed (Fig. 9, 3). This step, which on technical grounds simplifies the operation of gastrectomy very considerably for no vessels are cut in this dissociation of embryologically fused structures, is not recommended in gastrectomy for ulcer. The latter should be kept as conservative as possible. In gastrectomy for cancer it is the first essential of a radical operation.

In planning the adequate removal of lymphatic tissues, we have before us that prototype of well planned and successful cancer surgery, the Halsted operation for cancer of

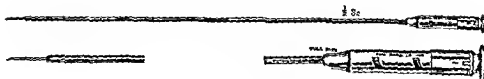


Fig 7 The author's needle for splanchnic anesthesia

the retroperitoneal tissue in this gap, that is, into the right crus of the diaphragm where it lies on the first lumbar vertebra (Fig 6). To do this safely it is necessary to have a guarded needle that can be slid along the finger till it rests on the vertebral body without tearing the glove, or injuring the liver or any vessels in the lesser omentum. Sixty cubic centimeters of the 1 per cent solution are injected slowly and diffusely round the splanchnic plexus.

The needle I have designed consists of three parts: the needle itself, a sheath, and a shield (Fig 7). A stud on the collar of the needle can engage in a slot in the sheath. In the first position the point is blunt and the shield forms a safe blunt instrument of exploration. In the second the point protrudes half an inch and pierces the peritoneum covering the splanchnic plexus.

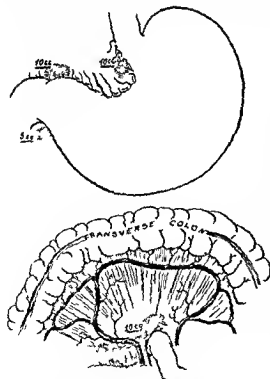


Fig 8 Mesenteric injections to supplement the splanchnic anesthesia

I supplement this splanchnic injection by a few further mesenteric injections of one half per cent solution, a modification I learned from Finsterer (Fig 8). Ten cubic centimeters are injected into the highest point of the 1 cc curve, 10 cubic centimeters into its lowest point, 5 cubic centimeters between the duodenum and hepatic flexure and 10 cubic centimeters into the base of the transverse mesocolon, where the middle colic leaves the superior mesenteric artery. The extra injections make doubly sure that the stomach, duodenum, transverse colon, and jejunum are insensitive, but I believe their chief value is to occupy a few minutes during which the splanchnic injection is taking effect, and to give the surgeon confidence. The combination of splanchnic and mesenteric injections is so harmless and so uniformly successful that I have never felt tempted to go back to splanchnic injections alone.

The present cure rate, judged on the 5 year standard, is from 5 to 10 per cent of all cases operated upon. If the inquiry is limited to cases suitable for gastrectomy, the cures increase from 15 to 17 per cent and if only the patients having had gastrectomies and leaving hospital alive are considered, the rate rises to 20 and 25 per cent. Even so this figure is one that no surgeon can view without a feeling of profound dissatisfaction. A discussion of the means whereby the cure rate may be improved involves consideration of how the disease spreads and where it recurs.

Cancer spreads by 4 main routes: by direct extension, by the blood stream, by lymphatics, and by dissemination of cells on a free surface. Many cancers of the stomach, when we first see them, are inoperable for 1 of the first 2 reasons, because the growth has invaded neighboring structures too widely for removal or because the liver contains secondary nodules. But these are usually late cases, and

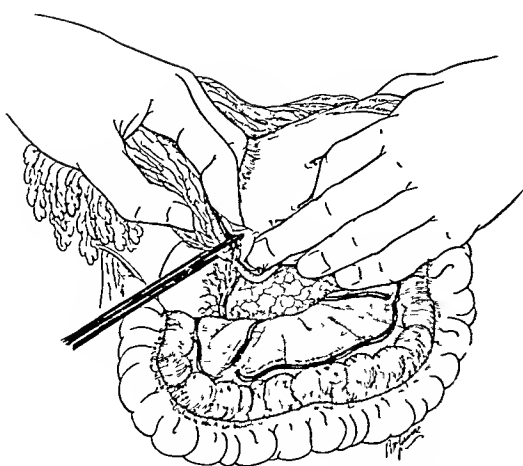


Fig 13 Ligature of the right gastro-epiploic artery at its origin

These glands drain the lymphatic plexuses in the submucous and subperitoneal coats of the stomach wall, in which cancer cells are usually found at some considerable distance from the parent growth. The whole stomach could be removed in every case, on the analogy of breast surgery, but total gastrectomy carries a high mortality, one that is never likely to be greatly reduced. It is due to the unsuturable qualities of the esophagus, and

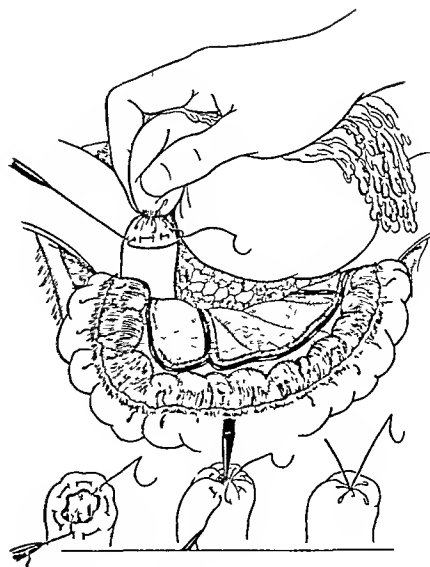


Fig 14 Author's method of duodenal invagination

could hardly be justified by any improvement in the cure rate that is in sight. Section of the stomach wall 4 inches beyond the palpable edge of the growth is in most cases sufficient to get beyond the extensions in the lymphatic plexuses, and when cancer cells have got beyond this distance they have probably got beyond removal even by the most radical surgery. On the duodenal side

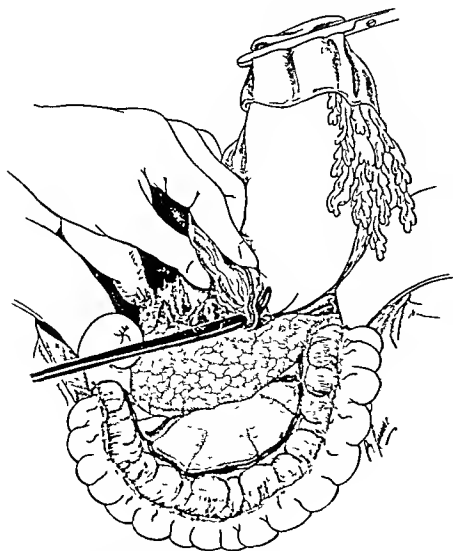


Fig 15 Exposure of the left gastric artery at its origin from the celiac axis trunk

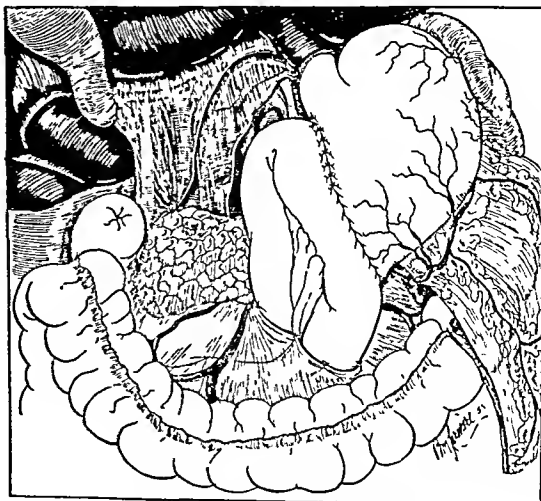


Fig 16 The operation completed

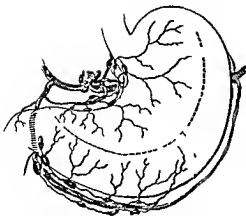


Fig 10 Simplified schema of the arteries and lymphatics of the stomach

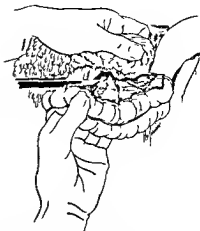


Fig 11 Opening the fusion plane between the omentum and transverse colon

the breast. In this operation, the growth, the organ in which it arises, the lymphatic channels which drain that organ, and the glands into which those channels empty, are removed in one piece. We start in the axilla, stripping the main vessels clear of all areolar tissue, tying all arteries and veins at their junction with the main trunk, leaving axillary vessels and brachial plexus here, and bringing down

the whole mass of fat and glands to be removed with the breast. A radical operation for gastric cancer implies that the vessels are similarly divided at their junction with the parent trunk, and that the whole lymphatic tract that accompanies them is removed with the stomach.

Two vessels only are important in this respect, the right gastro epiploic artery and the left gastric artery (Fig 10). The left gastro epiploic is small and far from the cancer area, and the right gastric is in most cases represented by a leash of vessels that supply the duodenum. The right gastro epiploic arises from the gastroduodenal in the groove between the duodenum and pancreas, and along it are grouped the glands into which the lymphatics of the greater curvature drain. The left gastric is a large artery that springs from the celiac axis just at the upper border of the pancreas, not much above the mid point of the lesser curve of the stomach. After a short course as a trunk it breaks into a number of branches, that spread in a fan to supply the upper border of the stomach from the cardia to the pylorus. The interval between these branches, and between them and the stomach is filled with fat and the lymphatic glands draining the lesser curve. The whole, artery, glands, and fat, is enclosed in a double fold of peritoneum, passing from the posterior abdominal wall to the lesser curve of the stomach, that often includes lobules of pancreas as well.

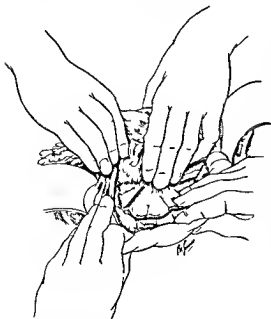


Fig 12 Freeing the omentum and superior leaf of transverse mesocolon from the colon and mesocolon proper

phatic clearance has been adequately performed, so that the aorta and intercrural fibers of the diaphragm are left bare, the splanchnic plexus is also resected in its upper part. I have not observed the cases sufficiently long to have established a regular clinical picture, but all in whom the removal of perigastric tissues has been radical have run a similar course. For the first 24 hours after operation they have been in excellent condition. After that they have shown abdominal distention, constipation, and vomiting of any fluids given by mouth. Flatus was voided, and some subjective relief experienced after enemas, but little fecal matter was passed

and the distention increased rather than diminished. With intravenous administration of glucose in water, together with prostigmine and acetyl choline at regular intervals, and ox bile enemas night and morning, the vomiting ceased, and the distention slowly subsided, but it has been nearly a fortnight before the abdomen reached its normal contour.

This operation does not introduce any new principles, but it attempts to carry gastrectomy for cancer to its logical conclusion, and to bring it into line with the operation for cancer of the breast. It should, therefore, add to the number of those who are permanently cured of this dread disease by surgery.

the dictum that cancer never spreads beyond the pylorus is as true as most aphorisms, cancer rarely spreads there, but if we examine the duodenum in all our specimens we will find a few in which the wall shows permeation for a short distance. It is, therefore, necessary in an operation that aims at being radical to remove a full inch of duodenal wall with the stomach.

The radical operation for cancer of the stomach may then be outlined briefly as follows. After the abdomen has been opened and the question of operability settled by careful examination and palpation, the assistant holds up the transverse colon to the limit of its mesentery, and the surgeon, extending the great omentum with his left hand, runs a sharp knife along the bloodless fold, now on the stretch, that unites the omentum to the colon (Fig. 11). He carries this dissection right down to the hepatic flexure, following the omentum to its absolute termination on the right, and on the left to within 2 inches of the splenic flexure. With a moist syah he then pushes the omentum upward, when it will separate from the transverse mesocolon, carrying the omental vessels and the posterior peritoneum of the lesser sac with it, until the ridge of the pancreas is reached (Fig. 12). On the right this separation brings the right free margin of the omentum, carrying the main trunk of the gastropiploic artery, off the head of the pancreas, where it can be tied as a single trunk (the only ligature that has yet been needed) as it leaves the gastroduodenal artery, a point beyond any recognizable glands of the greater curvature group (Fig. 13). The right gastric vascular bundle is next tied, and the duodenum cleared to 2 inches beyond the pylorus and divided 1 inch beyond it. I crush and ligature the duodenum, burying the stump with a pursestring suture. The method is simple, very safe, and allows more distal division with proper invagination (Fig. 14).

The pyloric end of the stomach is held up, and the lesser omentum, a flimsy structure at this point, is cut with scissors down to the liver. The vascular lymphatic bundle of the left gastric artery is next defined. The lesser sac is seldom the clear space of anatomy books, and congenital fusions between the

peritoneum of the posterior gastric wall and that covering the pancreas are common. These are easily separated by scissors and blunt dissection, and the vascular bundle then stands out as a thick fold. The splenic artery can be seen leaving its base to run along the pancreas and the trunk of the left gastric can be felt in it as a taut cord when the stomach is pulled forward and to the left (Fig. 15).

The artery is cleared, where it leaves the celiac axis, and divided between 2 silk ligatures. With scissors the fatty and glandular tissue is then separated from the aorta and diaphragm up to the esophagus. There should be no bleeding. The stomach is next pulled strongly downward, and the glandular and fatty mass is stripped down from the cardia to a point 2 inches down the lesser curve. The peritoneum is divided with a knife, and the loose tissue pulled down with dissecting forceps. The entrant arteries and emergent veins are ligatured flush with the gastric wall. Finally, the left extremity of the great omentum is divided between ligatures, from the point to which it was separated from the transverse colon to one on the greater curvature just below the lower pole of the spleen.

A mass of tissue is thus prepared for removal that includes the growth, the stomach below a plane passing from the lesser curvature  $1\frac{1}{2}$  inches from the cardia to the greater curvature just below the spleen, an inch of duodenum, the whole great omentum and superior surface of the transverse mesocolon, and all the lymph vessels and glands that accompany the left gastric and right gastropiploic arteries. The completion of the operation is a matter of technical preference rather than pathological principle. I prefer the valvular retrocolic gastrojejunal anastomosis first described by Lake, and I bring the duodenojejunal flexure above the mesocolon into the lesser sac, fix the highest part of the jejunum close to the diaphragm and close the mesocolic opening round the efferent jejunal loop only (Fig. 16).

This more radical dissection adds a little to the length and difficulty of the operation, but with local anesthesia the first is unimportant and the second moderate. It introduces fresh difficulties in the after care, for when the lymph

identified as discreet follicles but are diffusely scattered throughout the whole area and average in size about 1 millimeter in diameter. They are immediately below the superficial layer of the mucous membrane. In the fourth stage, these abscesses rupture and leave ulcers which appear as yellow spots scattered over the wall of the bowel, and which bleed on being wiped with a swab

The radiological evidences of the chronic stage are constant and marked by narrowing, shortening, hyperirritability, loss of haustration, and signs of destruction of the mucous membrane. Variations in the destruction of the mucous membrane are marked in the different stages of the disease and depend unquestionably upon the extent of bowel involvement, but the signs are too characteristic to be confused with other types of colitis. These laboratory evidences coupled with the clinical picture which is characteristic of thrombo-ulcerative colitis, assist in differentiating this type of colitis from other organic inflammatory lesions of the large bowel.

The clinical course of this chronic infectious disease of the colon is a characteristic one with an acute onset of many bloody stools likewise containing pus and mucus, the number of which sometimes ranges as high as 30 to 40 a day. Septic fever, anemia, and other evidences of infection exhaust and dehydrate the individual rapidly. This picture, along with sigmoidoscopic and roentgenographic evidence, easily and accurately establishes the diagnosis.

#### INDICATIONS FOR SURGERY

Medical management of chronic ulcerative colitis, which consists of a dietary regimen, administration of vitamin C, elimination of focal infections, and the use of vaccines and serum, is effectual in the majority of these cases to some degree. Intractability to medical treatment with a resulting damage of considerable extent to the colon, from which follows its loss of function and under which conditions the colon becomes filled with pus and detritus and is a source of absorption, is the principal indication for surgery.

Indeed, surgery for chronic ulcerative coli-

tis as for duodenal ulcer is indicated only for the complications which occur in 15 per cent of the cases. These complications, save only for hemorrhage and perforation, occur mostly in the chronic, intractable stages of the disease and fall readily into several classifications: (1) perforation, abscess formation, and hemorrhage usually occurring during the acute stages; (2) polyposis; (3) cancer developing on polyposis (this occurs in a definite percentage of cases, about 2.5 per cent); (4) visceral degenerative changes, (5) unique complications such as erythema nodosum, pyoderma gangrenosa, liver abscess, gastrojejunocolic fistula, etc., (6) evidences of focal infection, the lead-pipe colon filled with pus furnishing the source, as in arthritis, and (7) rectal complications such as stricture, fissure, peri-anal abscess, etc.

These complications, depending upon their distribution, the extension of the disease, and the acuteness or chronicity of the disease in each individual case, are indications for surgery of various types. The distribution is of particular importance because in 80 per cent of chronic ulcerative colitis cases as diagnosed by x-ray, the involvement of the large bowel is beyond the rectosigmoid juncture. In a series of 352 cases studied by Barga, Brown, and myself, roentgenography showed that the entire colon was invaded in 211 cases, 59.9 per cent, the lesion extended from the anus to the hepatic flexure in 240, 68.1 per cent, and from the anus to the splenic flexure in 69 cases, the rectum and sigmoid alone being involved in 26 cases.

This distribution is compatible with the data of other observers. Collins remarked that approximately 93 per cent of chronic ulcerative colitis is universal and only 7 per cent regional or segmental. In our experience, regional or segmental ulcerative colitis does occur, but very infrequently.

#### TYPES OF OPERATION

The operative procedures usually employed are. (1) colostomy; (2) ileostomy, (3) segmental resection by exteriorization; (4) subtotal colectomy following ileosigmoidostomy, and (5) subtotal or total colectomy following ileostomy.



## SURGERY FOR ULCERATIVE COLITIS

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THERE are few lesions of the gastro intestinal tract of a more controversial nature than so called chronic ulcerative colitis. Described first in 1875 by Wilks and Moxon, although a drawing by Cruvehier some thirty to forty years previously accurately depicted the pathology of the lesion, it is a disease of the large bowel characterized pathologically by ulcerations, abscesses, and scars, and clinically by a syndrome associated with diarrhea, blood and pus in the stool, violent febrile reaction, prostration and weakness followed by periods of remission and with a proneness to multiple complications. Many names have been given to this ailment, varying from "idiopathic colitis" to the present day designation, "thrombo ulcerative colitis." Almost certainly we in America have been discussing a different pathological entity from the one our continental confreres commonly describe as chronic ulcerative colitis, and probably this explains in part the divergent opinions on the etiology, pathology, and particularly the treatment of this not uncommon disease.

### ETIOLOGY

No phase of chronic ulcerative colitis is more debated than its etiology. Many organisms have been suggested as causative factors. Deficiency states as primary or secondary factors, are urged by some observers, and by and large there is scant unanimity of opinion regarding either the mechanism or the productive agents. That there are many types of ulcerative colitis, including tuberculous and amebic colitis, is general knowledge, but the pathological entity, usually referred to as chronic ulcerative colitis, is distinct from these.

The comprehensive, painstaking, and decisive work of Bargen, I feel, distinctly established the fact that a type of streptococcus produces 75 to 80 per cent of the cases of

ulcerative colitis. This type he terms, "thrombo ulcerative colitis" to designate its inception and pathology. The other 20 to 25 per cent of cases he points out, includes those in which there is an element of deficiency, some cases of allergy, a group of chronic bacillary dysentery cases, and that group in which the etiology is indeterminable. Bargen's researches which have been buttressed by application to clinical cases with undeniably advantageous end results in a large percentage of the group, have been, I believe, the most helpful factors in the modern management of this lamentable lesion.

### DIAGNOSIS

The diagnosis of a typical case of thrombo ulcerative colitis depends chiefly on a combination of the evidences of pathology revealed by roentgenogram and sigmoidoscopy. The findings by sigmoidoscopy are variable but from the experience of many trained proctologists, a characteristic picture of the appearance of the bowel during the active stages and remissions of the disease has been outlined which is constant and trustworthy. Since the progression in the bowel is essentially from rectum to cecum in the vast majority of cases, and its tendency is to appear most characteristically in its active stages in the lower segment of the gastro intestinal tract easily available to proctoscopy, the early and late appearances of the lesion can be accurately established.

Buie's description of the mucous membrane of the bowel during the period of activity appears to me entirely adequate. He divides this period into four stages. The first is represented by a hyperemia usually most marked in the lower rectum and anal canal, and which fades into the normal mucosa above, the second is but an advancement of the first type and manifests itself as an edema and thickening of the mucous membrane which bleeds on slight trauma, the third is represented by milky abscesses in the mucosa which are not

tion of the colon in 6 cases, 3 of chronic ulcerative colitis and 3 of polyposis

The single-barrelled ileostomy which was utilized in that series may be criticized on one point, namely, that a stricture developing along the course of the colon in a blind loop of bowel filled with pus, prevents drainage. Recently I have modified this technique somewhat by bringing out both ends of the bowel, dividing it, leaving the clamp on the cecal end, and thrusting a pezzar catheter immediately into the proximal loop for drainage. The procedure is as follows: A split muscle incision is made at a point mid-way between the umbilicus and the anterior superior spine of the ilium on the right side. The ileum is picked up 12 to 14 centimeters from the ileocecal valve, the blood supply of this portion is ligated, and the bowel is severed between clamps, with a cautery. Instead of dropping the cecal end back as in the original technique, the clamp is left on the cecal end, a purse-string suture is placed around the ileal end, and a pezzar catheter is inserted. The two ends of the bowel are separated by the full thickness of the abdominal wall. The clamp is left on the cecal end for 48 hours or longer, but the immediate drainage of the ileostomy is advantageous.

The mobilization of the ileostomy from the abdominal wall in the second stage of the procedure is a little more difficult than when the cecal end is turned in and the bowel dropped back into the peritoneal cavity. Conditions in each individual case will determine which particular type of ileostomy is more desirable.

Ileostomy is always accompanied by great loss of body fluids and a concurrent decline in body weight. There is marked disturbance in mineral metabolism, loss of chlorides in the blood plasma, and a reduction of the serum calcium because of rapid and excessive loss of fluids. In addition, it is much more difficult to care for an ileostomy than a colostomy, but a satisfactory ileostomy bag which fits closely around the opening, keeping the discharge away from the skin has been adequate in our hands. The apparatus is made of non-metal and has a ring with a flange around it which fits a tight rubber dam through which a hole

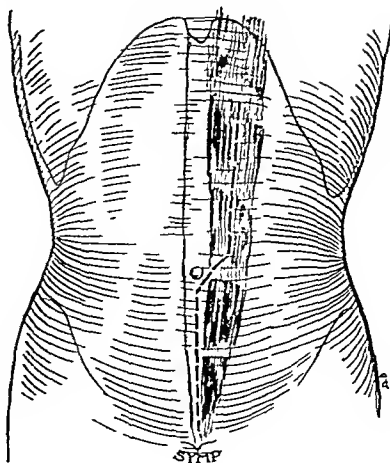


Fig 2 A long incision in the median line below the umbilicus and advancing upward splitting the muscle fibers of the left rectus muscle beyond that point as high as necessary, is the most useful incision. Regardless of whether a partial or total colectomy is to be done, the mobilization should be made from right to left and this incision allows handling of the entire colon most readily.

is made to fit the ileostomy so that the soft dental rubber sheeting of the dam is the only part touching the skin. Proper dietary habits will be of great assistance, and after a period of 3 to 4 months the ileum will assume in part the function of the colon, becoming larger and hypertrophied, and the patient will begin to gain weight and strength.

**Colectomy.** Before a colectomy, subtotal or total, is undertaken, pre-operative rehabilitation and decompression should be instituted with the most meticulous care. Adequate hydration by repeated small transfusions, intravenous administration of 5 per cent glucose in normal saline, plus a high caloric diet, are advantageous. Occasionally colonic irrigations may be of help, although frequently they are useless. Lead and opium pills 48 hours prior to operation are advantageous. These efforts increase the general resistance as well as supplement the advantageous effects of self-immunization, and thereby increase the margin of safety.

Removal of part of the colon by exteriorization or by a resection and immediate anastomosis has a limited field of usefulness. Actually, I question if either of these procedures is practical for chronic ulcerative colitis even

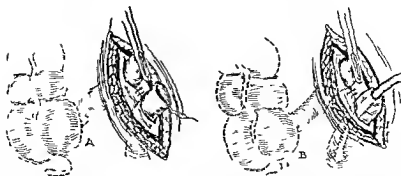


Fig 1 The split muscle incision has been made mid way between the anterior superior spine of the ilium and the umbilicus the ileum picked up 12 or 14 centimeters from the ileocecal valve the blood supply ligated and the ileum divided between clamps. The clamp is left on the cecal end of the ileum and a pezzar catheter put in the proximal loop for immediate drainage. The two ends of the ileum are separated by the full thickness of the abdominal wall for about one half inch.

**Colostomy** Colostomy is of relatively small use in most cases of chronic complicated ulcerative colitis. First, the disease generally involves the entire colon, second, if one makes a colostomy above the infected area in a regional ulcerative colitis, the disease has a tendency to leap over the colostomy and involve the segment above. How this is accomplished, whether by direct continuity of tissue, by the lymphatics, or through blood stream invasion, is not definitely established, but it has occurred not once but several times in my observation.

Jones, of Cleveland, has suggested that possibly a colostomy with complete division of the bowel and mesentery might be a useful operation for colitis situated in the left half of the colon. So far as I know, this procedure has not been tried out in any large series of cases and its utility remains to be proven.

**Ileostomy** Ileostomy has 2 indications: first, in chronic ulcerative colitis either as the first stage of a graded procedure for colectomy, or as a permanent drainage operation, and second, in the acute fulminating stage. In this latter condition, I question if ileostomy or any other operation is of much use, but if surgery is indicated for hemorrhagic, fulminating infection or the acute toxemia which goes with a violent case of ulcerative colitis, by passing of the fecal current by ileostomy is the method of choice. It should not be performed in uncomplicated cases and except in

a very small selected group of the acute variety. As an instance of how futile ileostomy is as an agent in the acute group, two hemorrhagic cases in my service serve as examples. In both cases ileostomy was helpless to stop the hemorrhage and a fatal outcome resulted. Again, I would urge that once an ileostomy has been established, its closure is distinctly questionable. I have closed one case which remained symptom free for 2 years when an exacerbation necessitated the performance of a second ileostomy. Twice I have closed ileostomies with exacerbations, resulting during the hospital period, with a fatal outcome in each case.

In 1932 with Barga and Brown, I reviewed the histories of 82 patients upon whom ileostomy had been performed for acute fulminating ulcerative colitis and progressive complicated ulcerative colitis with evidences of absorption. Following operation in this group there was a hospital mortality in 26 cases, or 31.7 per cent. This immense mortality and the unsatisfactory end result of ileostomy, plus the more satisfactory results of a better managed medical regimen, influenced us to abandon it more and more each year except as one part of multiple stage procedures.

The technique of ileostomy which I have found useful, with certain modifications, was described in *SURGERY, GYNECOLOGY AND OBSTETRICS*, August, 1932. I utilized the original technique as a preliminary step to total abla-

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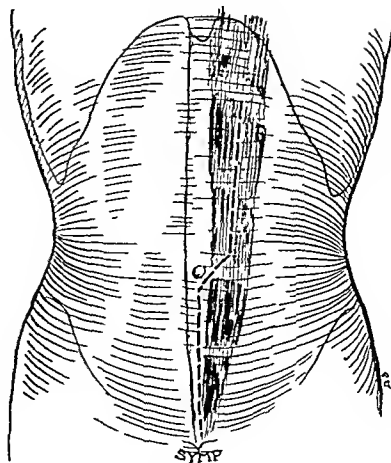


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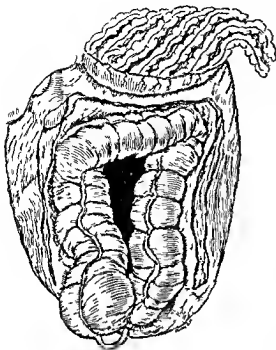


Fig. 3 To illustrate mobilization of the colon on the right side and preservation of the omentum. Ample peritoneum is deliberately saved to cover all raw surfaces. Widespread dissection is not essential as in dealing with malignancy.

of the segmental variety. On the other hand, subtotal colectomy, with ileosigmoidostomy or ileocolostomy, where the disease is limited to the right side of the colon and transverse segment, is distinctly a satisfactory procedure in that small group of cases in which the pathological process is so isolated. Subtotal colectomy following ileosigmoidostomy, whereby the entire colon down to the recto-sigmoid juncture, is sacrificed for definite indications, is a useful operation and is usable in that group of cases in which for one reason or another it is not practical to do a third stage and removal of the rectal stump.

This operation presents no great technical difficulty since there does not have to be a widespread removal of the mesentery, as for malignancy, and in addition it is not only more simple, but desirable to save the omentum, another condition different from that dealt with in malignancy. The operation is usually carried out through a long left rectus

incision, the lower part of which is a midline one from the umbilicus to the symphysis. The upper margin of the incision is extended as high as is necessary to mobilize the splenic flexure. The mobilization is usually made from right to left and freeing the cecum is sometimes difficult because of the type of ileostomy which has been made. The John Young Brown type of ileostomy is a loop variety of operation and the cecal end of the ileum is opened on the abdominal wall. This has to be mobilized, inverted, and dropped back and the mobilization of the cecum continued from that point.

There are two difficulties which one must keep in mind throughout the whole procedure of mobilization and they are the likelihood of encountering chronic pericolic abscesses which rupture easily into the peritoneal cavity or, owing to the friability of the wall of the colon, may open into its lumen, and second, the friability of the mesentery which is shortened and thickened, and in consequence, hemorrhage by retraction of the vessels into this fat may become a problem. The mobilization is begun after the ileum is freed and by rotating the cecum mesially and dividing the peritoneal leaflet at its fusion with the parietal peritoneum. The blood vessels are clamped and divided as they appear and the dissection is carried upward toward the hepatic flexure in the same manner as though one were dealing with cancer, except for the sacrifice of the mesentery. The two main structures to be identified are the right ureter and the retroperitoneal portion of the duodenum. The vessels having been ligated and divided as they appear, it is best to peritonealize the raw surfaces after the dissection has progressed to the hepatic flexure, thus completing the right half of the operation entirely before proceeding to the transverse segment. By drawing the omentum upward, one is able to separate it easily from the transverse segment, ligate the blood vessels in this portion, peritonealize the raw surfaces, and move over to the splenic flexure with little or no difficulty. The latter is difficult to mobilize since the attachments are short and when they are supplemented by additional inflammatory bands, the difficulty is increased. The spleno-

colic ligament is divided, the vessels to the segment are clamped off easily, and the mobilization of the descending colon and sigmoid proceeds. The left parietal peritoneal leaflet is divided similarly, the colon is rotated mesially, the surgeon working toward the pelvis. When one has freed the sigmoid down close to the rectosigmoid juncture, preserving if possible the superior hemorrhoidal vessels, it is necessary to locate a point at which the bowel will be divided. If a long piece of sigmoid is left intraperitoneal, it will be necessary to complete the operation as a combined abdominoperineal resection. If, however, one divides the bowel close to the rectosigmoid juncture and makes a new pelvic floor, posterior removal can be done later with less risk.

In dividing the bowel at whatever level, experience has taught me that it should be grasped with a soft rubber, right angle clamp and cut off with a cautery rather than to utilize a crushing clamp which will cut through the bowel wall, leaving the severed end wide open and spreading contamination. I think it wiser merely to sew over the end of the bowel rather than to try to invert it, for inversion of this thickened, friable piece of intestine is usually impossible. The end is wrapped in iodiform gauze and this is brought out of the lower incision, after being wrapped in rubber tissue, as a drain.

The third stage of the operation is either a combined abdominoperineal removal of the rectum similar to that done for cancer, or a posterior resection by Mummery's technique, depending upon where the division has been made and where the blood supply has been ligated. After this stage there is an evident change in the ileostomy, its irritability, and not infrequently the tendency to diarrhea become noticeably improved. Frequently the stools are diminished in number and the function of the large bowel taken on more equably. For this reason it seems to me that subtotal colectomy which has been preceded by ileostomy, should uniformly be followed by removal of the rectum, unless contra-indicated.

#### MORTALITY FOLLOWING RESECTION

The hospital death rate following total or subtotal colectomy for definite indications in

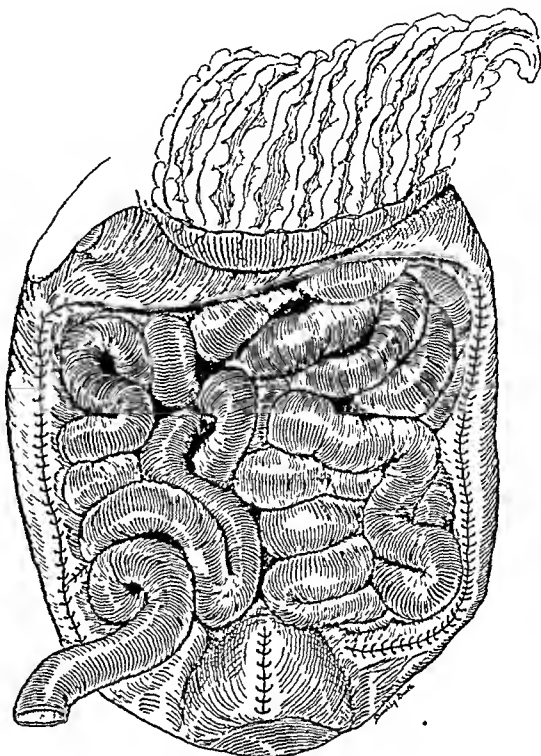


Fig 4 Illustrating the completed operation of subtotal colectomy following ileostomy. The peritonealization is satisfactory and the rectal stump dropped down retroperitoneally after ligation of the inferior mesenteric vessels. This type of operation can be followed by posterior resection for removal of the rectal stump. If more sigmoidal stump is left, a combined abdominoperineal operation is necessary.

properly selected cases is consonant with the mortality in other types of surgery of the colon for major organic lesions. The main indications for colectomy are: (1) congenital adenomatosis, and (2) refractory or complicated ulcerative colitis. It is quite apparent on survey of the scant literature available that when resection for chronic ulcerative colitis is indicated, the mortality figures are quite satisfactory.

In my own series of 12 colectomies, 7 total and 5 subtotal, the operation was performed for chronic ulcerative colitis 5 times and for adenomatosis 7 times. There was 1 death in this series and it was in a case of adenomatosis; no mortality occurred in the ulcerative colitis group. Cave has recently reported 2 total and 4 subtotal colectomies for chronic

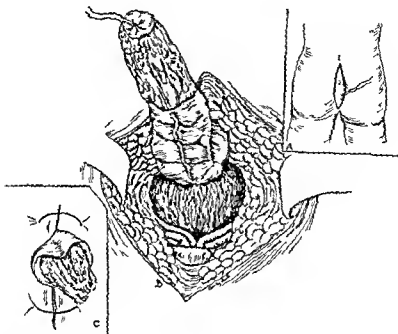


Fig 5 Illustrating resection of the rectal stump extraperitoneally after the method of Mummery

ulcerative colitis with no deaths, and Cattell in a personal communication informs me that he has done 16 total and 6 subtotal colectomies for ulcerative colitis with a single death. These are small groups, to be sure, upon which to reckon statistics, but no very large series of colectomies having been published, they indicate that this formidable procedure of ablation of part or all of the large bowel may be carried out under proper circumstances with a reasonable casualty list.

These cases give the appearance of being extremely bad risks because of dehydration, desiccation, and generally exhausted condition due to absorption. On the other hand, the long time during which self immunization has taken place is an advantage to them against infection, and adequate preliminary preparatory treatment consisting of repeated transfusions and daily administration of large amounts of 5 per cent glucose in saline, raises their physiological equilibrium to a level safe for extensive surgical maneuvers.

The loss of the colon for whatever reason is not attended with serious disturbances of

physiology and when the ileum has assumed in part the function of the large bowel, and the disturbances in blood chemistry and mineral metabolism, which are temporarily upset, have been balanced and weight and strength have improved, many of these individuals return to a useful status.

While it is clear that surgery is indicated only under rare circumstances in chronic ulcerative colitis, the indications are definite that the mortality is reasonable and cure by removal of the extensively diseased bowel is effected under these circumstances in which less radical measures are inadequate.

#### CONCLUSIONS

1. Surgery in ulcerative colitis is indicated only for complications. These complications occur, first, as rectal or perirectal lesions, or second, usually affect the entire colon from rectosigmoid to cecum. The removal of part or all of the large bowel for chronic ulcerative colitis is definitely desirable when the colon has lost its function and becomes a focus of absorption.

2. Surgery in the acute, fulminating or hemorrhagic forms of ulcerative colitis has few, if any, advantages. In this type of condition, ileostomy which completely by-passes the fecal current may be done under local anesthesia and occasionally appears to accomplish something.

3. Operations for colectomy, total or subtotal, should be carried out in multiple stages. Multiple stage operations increase the margin of safety enormously and sufficient time after performance of ileostomy should be allowed to elapse before resection is undertaken, to replace fluid loss, balance the blood chemistry, and increase body weight and strength.

4. Mortality statistics, following colectomy, parallel statistics for surgery of other major lesions of the colon.

5. The treatment of chronic ulcerative colitis is predominantly medical and no operation should be attempted until all other efforts have proved futile. But when surgery is undertaken, it should be only after adequate and prolonged pre-operative preparation and rehabilitation.

#### BIBLIOGRAPHY

- 1 BARGEN, J. A. Personal communication
- 2 BUTE, L. A. Chronic ulcerative colitis. *J Am M Ass*, 1926, 87, 1271-1274
- 3 CATTELL, R. B. Personal communication
- 4 CAVE, HENRY W. The surgical treatment of intractable chronic ulcerative colitis. *Ann Surg*, 1938, 107, 806
- 5 RANKIN, F. W. Colectomy for adenomatosis and pseudopolyposis. A report of five additional cases. *Ann Surg*, 1935, 102, 707-723
- 6 RANKIN, F. W., BARGEN, J. A., and BROWN, P. W. Indications for and technique of ileostomy in chronic ulcerative colitis. *Surg, Gynec & Obst*, 1932, 55, 196-202



## REGIONAL ILEITIS

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IT IS just about 6 years since the publication of a paper (4) on the clinical and pathological description of a disease entity, styled regional or terminal ileitis. This is a chronic, non specific, granulomatous, inflammatory process occupying for the most part the terminal segment of the ileum, and characterized by diarrhea, fever, obstructive phenomena, and often by fistulous tracts, a disease which lends itself favorably to surgical operation. While making no stated claim to priority, we did feel that although non specific granulomas of the alimentary tract had previously been noted by several observers (17, 18, 25), the clear cut clinical picture, the roentgenographic appearance, the course and surgical treatment had never been intelligently portrayed, nor had the clinical condition received proper recognition.

Confirmation by current literature of the symptom complex followed within a few months (2, 11, 16) and still continues. Many of these authors confirmed in full the detailed features as we portrayed them; some have cast doubt on the disease as a clear cut entity. Intelligent criticism and supplementary observations of great interest and importance have received attention. On the whole, the subject has attracted the surgical fraternity into whose hands most of the cases either fall, or will fall eventually, and it is from them, with their biopsy *in vivo* that the most helpful ideas and the most pertinent suggestions have emanated.

To a large extent the original conception stands, nothing has been subtracted, but considerable has been added. It had been observed (1) that the disease might, on occasion, occupy other than just the terminal ileum, and that the upper ileum and even the jejunum might be affected independently of, or in conjunction with, the more consistently involved terminal segment of the ileum. The iron clad

rule of non involvement of the cecum and colon in true regional ileitis was soon broken down (3, 5), a fact to which we again acceded, adding the concept, exceptional though it be of a combined ileitis and colitis. New variations of the original fistulous tracts have been observed and confirmed.

The surgical approach to the solution of the problem has been a field of debate, the partisans of radical resection opposing the antagonistic upholders of short circuiting palliative measures. The suggestion has been made that the disease is a medical problem entirely and that surgery is superfluous.

Although the time elapsed is short, as time is measured in the world of science, nevertheless the opportunity is propitious for a restatement of views as judged from a broader concept and an ever increasing personal experience, with due acknowledgment of the opinions and statements of other competent observers.

This report is based upon 110 personally observed patients, 73 of whom have received confirmation by operation. Practically all of the remainder have been examined repeatedly and where feasible, an adequate follow up has been established and maintained. One hundred and ten cases seen in 6 to 8 years give an idea of the frequency and distribution of this singular disease. Its incidence is almost as great as that of ulcerative colitis, perhaps in the proportion of 1 case of ileitis to every 2 cases of colitis. Neither disease is rare. If alertness and the ability to recognize and interpret clinical symptoms be maintained, the cases will be encountered frequently in all classes of the population.

The point has been made in the literature that the disease appears to have its greatest incidence in the Hebrew race, if not exclusively so. This probably arises from the fact that the earlier confirmatory reports originated from the eastern seaboard, from such cities as Boston, New York, and Philadelphia, or from cities like San Francisco and Chicago with relatively large or proportionately large Jew

n populations. The rural districts to be heard from. My own experience in many of the published articles is purely racial distribution of the disease here or abroad. Sweden, South Holland, Canada, England, and Oklahoma instances of the disease in gentiles better acquaintance and a more wide recognition of the symptomatology, it questionable impression that the disease has been proved to have neither real racial predilection nor eventually, any preference for color. I have personally observed no case in the negro nor in the Porto Rican population of this cosmopolitan city.

The distribution of the sexes is not exactly even as is usually stated. There seems to be a definite preference for the male, the ratio being 66 males to 44 females, a proportion of 3 males to every 2 females.

The disease remains one of youth showing a definite predilection for the third and fourth decades of life. The youngest patient I have ever seen was 15 years old, the oldest, 58 years of age. The distribution of regional or terminal ileitis with regard to age, as I have found it, is as follows: first decade, none seen, second decade, 10 cases; third decade, 48 cases, fourth decade, 21 cases, fifth decade, 11 cases, sixth decade, 2 cases. More cases are noted between the ages of 20 and 30 years than in all the other decades combined. The average age of the illness, when seen, is 27.8 years. Many of the older patients have histories of such long duration that the origin of the diarrhea is easily dated in the previous decade or decades of life. Yet we must concede the fact that occasionally one does recognize a case *ab initio* in later years. A physician must be loathe, however, to diagnose ileitis in older persons without excluding the commoner diseases of middle life, particularly cancer.

Three times my opinion has been asked regarding the possible rôle of trauma in initiating ileitis or in aggravating present symptoms. On two occasions, automobile injuries, and on another, violent effort were impugned as causative agencies. In the 2 instances of automobile accidents, mild in themselves, no connection could logically be entertained be-

tween the slight trauma and a subsequent operation for chronic regional ileitis. In the third instance, hemorrhage into a pre-existing ileitis was claimed as the result of strenuous effort while engaged in an industrial pursuit. Here, some case for an exaggeration of pre-existing symptoms may possibly be made. To my mind it is unlikely trauma bears greater relationship to ileitis than to appendicitis.

#### CAUSATIVE AGENCIES

An actual etiological agency as the cause of ileitis has not been determined. We seem no nearer to the solving of this problem of the etiology of ileitis than we are to the similar puzzle of the creative factor in a case of ulcerative colitis. The latter disease has engaged close attention for many more years with extensive bacteriological research and animal experimentation without an acceptable solution. Both are regarded as non-specific diseases in which no single agent, bacterial or virus, can be successfully implicated.

The appendix has been accused by some (12), but its non-involvement in the pathological process in all but the most exceptional circumstances would seem to exclude it as an incriminating factor. In at least 33 per cent of our cases the appendix had been removed at a previous exploratory operation without affecting or inhibiting the course of the ileitis, nor did the appendix show any pathological changes characteristic of the disease.

Lymphatic block at the ileocecal junction with its maze of rich lymphatics has been accused of originating the disease (21), a type of lipin absorption from the lacteals being the provoking agent in a mononuclear cell type of infiltration. Experimental reproduction of lymphedema in this segment by injecting bismuth into the lymphatics has been adduced in support of this view. This hypothetical conjecture has no support in fact. The occasional recurrence of the disease process at higher levels of the ileum and the jejunum after previous resection of the terminal segments about the ileocecal angle speak loudly against a purely lymphatic block and in favor of a persisting residual infective agent.

I have seen the disease 3 times in siblings. The 2 earlier instances were reported in a pre-

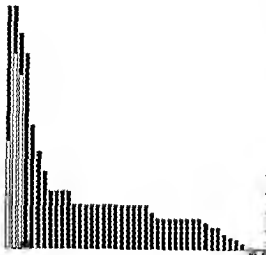


Chart 1 Distribution of ileitis and jejunitis

viously published paper (6), the more recent instance is that of 2 brothers simultaneously affected by a rather acute process. This surely suggests a common infecting agent, probably bacterial, rather than a mere familial or tissue tendency to the disease. In none of these cases, nor in any other of the operative material, have I ever been able to recover a dysentery organism from either the stool or culture of the resected specimens. Moderately high agglutinations in the patients' serums have been observed occasionally, 1:320 Hiss was seen in 1 case. But the significance of agglutination reactions against dysentery organisms has been questioned recently as specific evidence for the existence of bacillary dysentery, unless supported by the actual recovery and growth of offending bacterias. The reaction is too general and too non-specific to be of any great significance.

The corroborative evidence offered by Felsen (9) to the incrimination of bacillary dysentery is not convincing but suggestive. The terminal ileum may be involved in severe, universal colitis caused by dysentery, as it is in the non-specific type, in 24 per cent, but the involvement of the ileum alone without participation of the colon is nowhere described in standard textbooks on pathology, nor will pathologists of repute accept such a conception. Felsen's epidemiological and clinical observations, regarding the persistence of ileitis

in a few survivors of a true epidemic of bacillary dysentery in Jersey City and elsewhere, is interesting but not convincing, because neither he nor others were able to recover a culture of the organisms in resected specimens.

The microscopic appearance of mononuclear cells in whorls with occasional giant cell inclusions suggest tubercle. The histological similarity to Boeck's sarcoid, as noted by Snapper (22), places both diseases as well as any other similar granulomatous process in the class of pseudotuberculosis. The disease is definitely not caused by the Koch bacillus.

#### PATHOLOGY

The pathological characteristics of the disease, as originally described, remain essentially identical with our original conception and require but few additional observations. The main thrust of the disease falls upon the terminal segments of the ileum beginning abruptly at the ileocecal valve and advancing upward along the intestine for a variable distance. The vast majority of the cases involve from 2 to 12 inches of the terminal segment of the ileum, but cases have been observed in which as many as 36 to 50 inches have been noted to be continuously affected. In 6 patients the whole of the lower and upper ileum was affected and in 2 at least the jejunum was probably similarly involved. In 1 case seen at autopsy, the small intestine including even the duodenum, was affected by a continuous inflammatory granulomatous process.

The extent of the involvement is usually announced by the presence of enlarged, succulent, mesenteric lymph nodes adjoining the mesenteric attachment of the intestine. These signal nodes appear paralleling the involved areas, and disappear when the unaffected or skipped-clear area is palpated. The nodes are never calcified nor do they often break down, they constitute an excellent guide to the exploring surgeon in determining the extent of the lesion. The presence of these guiding inflammatory nodes suggests the possibility that so called mesenteric lymphadenitis, as seen particularly in children, is none other than acute ileitis with minimal mucosal lesions and maximal lymphadenopathy. In the light of our increasing experience with ileitis, the concept

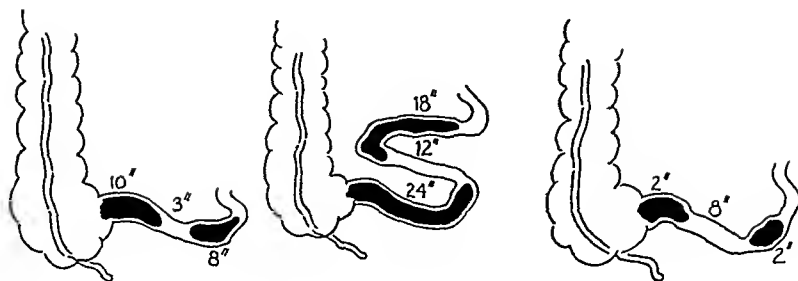


Chart 2. Skip areas in ileitis

of an independent disease such as mesenteric lymphadenitis, distinct and apart from ileitis, will bear more careful study. The transition of acute lymphadenitis to chronic ileitis has never been observed but is a reasonable potentiality.

Skip areas. The inflammatory process in the ileum is not always continuous, the pathological unity often being broken by one or more skip areas. These areas range from 2 to 12 inches, or as seen in 1 case, as many as 18 inches. They are of the greatest significance at the time of operation, for failure to note the higher skip areas means insufficient resection and accounts for the not inconsiderable percentage of recurrences.

Occasionally, though not often, it is found that the terminal ileum as well as some segments of the colon are similarly involved as observed in 8 cases. More often the cecum and ascending colon are affected in a continuous manner with the terminal ileum. At other times skip areas are seen in the colon, so that the process may appear, for example, in the terminal ileum, ascending colon, mid-transverse colon, or occasionally even in the sigmoid, with these various areas being separated by wide segments of unaffected mucosa. Fortunately for the original clear-cut description of regional ileitis, these combined cases of ileocolitis are few in number, for they represent very difficult problems in surgical judgment. When clinically observed over long periods of time, the colon involvement will often regress with only the diseased ileum remaining for resection. The converse, however, is often true.

Occasionally, the terminal ileum and colon are void of disease but the process is seen

involving a limited portion high in the ileum or even in the jejunum. These sections may be only a few inches wide in extent, or may involve more widespread areas with predominant lymphadenopathy. Resections at these points are more difficult and short-circuiting operations usually insufficient. While fistulization rarely takes place from sole involvement of these higher sectors of the jejunum and ileum, Dr A A Berg noted 1 such instance: a fistula originated in a diseased loop of the jejunum and ended in the sigmoid.

#### SYMPTOMATOLOGY

The onset of the disease is occasionally acute, as seen in 11 cases, but ordinarily the history is one of a chronic illness progressing insidiously. At first there are only occasional bouts of discomfort or diarrhea, later these are followed by continuous intestinal frequency, fever and pain. Sixty-two patients had a history dating from 1 to 5 years; 15 patients, 5 to 10 years; 8 patients, more than 15 years of almost uninterrupted illness. During this prolonged period of non-recognition, various diagnoses were maintained usually nervous diarrhea with a psychoneurotic background, at times food allergy, and undulant fever with peculiar intestinal changes was noted (24).

The appearance of the mass in the lower, right quadrant or across the lower abdomen is a later manifestation and betokens the spread of the disease into the mesentery, or the formation of sinuous, fistulous tracts may occur, and again there may be agglutination of variously affected coils of the involved small intestine. Not infrequently the mass represents a localized, low-grade, inflammatory peritonitis due to a walled-off slow per-

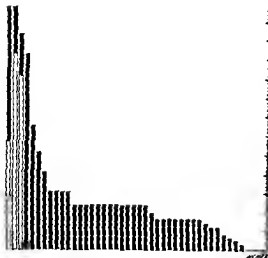


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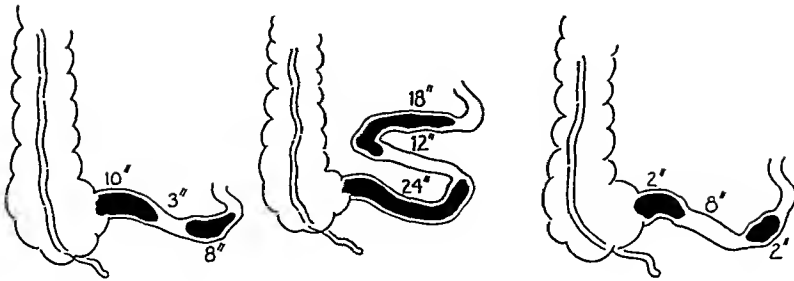


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foration of the ileum, or to the breaking down of infected lymph nodes. The mass may resemble an appendiceal abscess, a urachal cyst, a diverticulitis with perforation, or possibly a secondary intestinal tuberculosis.

Obstructive symptoms do not appear as frequently as hitherto believed. In only 10 cases was intestinal obstruction a predominant phenomenon, which was always partial and incomplete and associated with borborygmi, gurgling, and the palpation of the distended intestinal loops. An inflammatory mass with a long chronic history and signs of obstruction, when occurring in a young person, is highly suggestive of ileitis.

### FISTULAS

The outstanding characteristic of this pathological process is its tendency to form fistulous tracts, it is by these tracts that the disease is known. These fistulous tracts are many and diverse, they travel wide distances and appear at unexpected exits. They seem to be chemical or lytic in action, and thus is created possibly by the solvent action of seeping intestinal juices containing activated digestive enzymes. They are seldom highly infectious and cause only a low grade, inflammatory abscess before perforating to the exterior. The following fistulas are recognized:

Internal fistulas, 11 cases These originate in the terminal ileum but end in some segment of the colon, usually the cecum or the sigmoid. The ubiquitous and redundant sigmoid is frequently drawn up to the right, lower quadrant and attached to the inflammatory mass by an intercommunicating fistulous path, or the fistula may seek the transverse colon for its exit, or the rectum, the urinary bladder, vagina, or some contiguous and adherent loop of the ileum or the jejunum.

External fistulas, 12 cases These fistulous tracts, again originating in a porous ileum, usually seek the anterior abdominal wall and follow the scar of a previous laparotomy. In fact, I recall no instance of an external fistula to the anterior abdominal wall except in cases in which a previous operation had predisposed the tissue to such a process.

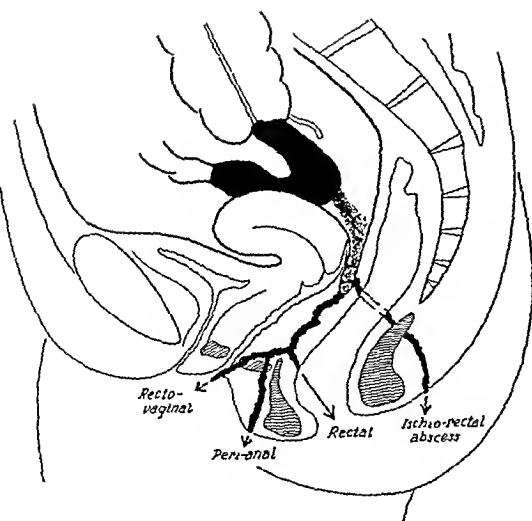
Fistulous tracts to the inguinal, lateral abdominal walls and to the right lumbar regions

occur without antecedent operative measures and are apparently of a spontaneous nature. The most interesting are those in the lumbar gutter where they may be observed to form plural openings in a straight vertical line (237), emitting thin intestinal content.

Peri anal, rectal, and rectovaginal fistulas (8), 20 cases These latter fistulas are the most common type of fistulization present in ileitis and deserve the most careful consideration. The methods of formation may be various. Most of the fistulas in ano occur as the result of infection in the rectal crypts of Morgagni by transported, contaminated, fecal material. This explanation probably answers for the large majority of simple peri anal fistulas.

But some of the fistulous tracts have a far more circuitous course. The diseased, heavy, and soggy terminal loop of the ileum lies usually on the pelvic floor near the pouch of Douglas, ascending at an acute angle to enter the ileocecal junction. Infectious pus and material escaping from the porous terminal loop of the ileum seep downward, infecting the pelvic peritoneum and retroperitoneal fat and burrow through the pelvic fascia by a fistulous tract which tends downward. This tract may make its exit into the rectum above the sphincters, or, piercing the sling like attachments of the levator ani to the sphincters, may exit at the peri anal margins. If the infectious fistula pierces the fibers of the levator ani laterally, the ischiorectal fossa is contaminated, and the abscess thus formed will make its exit as a pararectal fistula. In the female, the fistulous tracts may traverse the rectovaginal septum and make its exit in the perineum, the vagina, the rectum, or as a rectovaginal fistula!

The course of these long fistulous tracts is very difficult to follow. Lipiodol injections made from below are usually lost in a pool of radio-opaque material somewhere in the pelvis, the exact location of which defies analysis. On occasion we (8) have noted a streak of barium pointing sharply downward from the terminal ileum as seen during roentgenographic studies. At the same time or in the same case a lipiodol injection of a peri anal fistula will point sharply upward to the same



JHB

Fig 1. Diagram showing the course of fistulous tracts from diseased ileum to various points on the perineum

direction and location. While the direct path and continuity has not been unequivocally demonstrated, this explanation is offered as a reasonable and plausible analysis of the various chemical and anatomical factors involved.

The clinical significance of these peri-anal and rectal fistulas has not received sufficient recognition. They frequently precede anywhere from 1 to 14 years the onset of active diarrhea and abdominal pain, constituting the one prodromal symptom of regional ileitis.

In 1 instance a patient was admitted to the surgical services of the hospital for routine hemorrhoidectomy. A simple fistula-in-ano complicated the hemorrhoids. An alert interne, taking a routine history, discovered a story of mild diarrhea to which the patient himself had paid no attention. A gastrointestinal roentgenographic study exposed the presence of a terminal ileitis. Such an instance might be multiplied many times, if it were recognized by internists and surgeons that fistula-in-ano is so often a precursor of regional ileitis before the onset of active abdominal symptoms. Perhaps there is some pathological, bacteriological, or chemolytic affinity between fistula-in-ano and regional ileitis, since the same infectious process invades different but analogously susceptible regions of the intestinal tract.

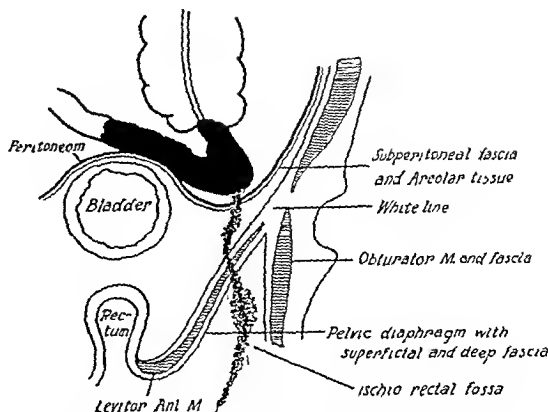


Fig 2 Diagram showing the course of fistulous tract from diseased ileum via the ischio-rectal fossa to the perineum

### COURSE AND PROGNOSIS

The acute cases of ileitis whether explored by operation or not, will, if not interfered with, run a variable course. Of the 11 patients seen with acute ileitis, many were explored but not otherwise resected; 3 have undergone a recession of their symptoms, suggesting that a spontaneous cure is possible occasionally. The experience of Koster (14) is similar to our own. He explored 6 patients with acute ileitis without further interference. They seem to have done well up to the time of the publication of his paper, though the duration of the follow-up is not specifically stated. However, considering the chronicity of the typical ileitis case, it is quite certain that the last word has not yet been said in these many instances (20). The 8 remaining patients did poorly; 6 of them were operated upon eventually.

The chronic case of ileitis that remains unoperated upon may come to grief. Two such cases came to autopsy. In both of them death was due to pelvic peritonitis with diffuse intra-abdominal suppuration and abscess formation. In the second case, a pelvic abscess perforated the urinary tract so that feces were passed through the urethra.

The usual chronic ileitis case runs a long course over a space of years. It is characterized by marasmus and nutritional disturbances due to protracted diarrhea and anemia, and ends eventually in the formation of multiple fistulas, or with the late picture of a



partial intestinal obstruction, when operative indications can be denied no longer. Spontaneous healing in a case of chronic regional ileitis has not been observed.

#### DIFFERENTIAL DIAGNOSIS

It can no longer be said that ileitis is a disease which defies accurate, pre-operative diagnosis. The clinical course is so typical, the negative sigmoidoscopy, and the barium enema which rules out the existence of a right-sided colitis, force one's attention to the small intestine as the most probable origin of the inflammatory diarrhea.

Roentgenographically, both the barium enema and the barium meal are highly efficient measures for the detection of the characteristic string sign (13, 10), or of an equally suggestive tuzziness and filling defect in the terminal or lower segments of the ileum. Very rarely will the roentgenogram fail. In 1 case only, a highly suggestive history led to the diagnosis of ileitis. A most competent radiologist declared the x-ray plates negative. Nevertheless laparotomy disclosed a typical but early terminal ileitis. This mistake in the interpretation of x-ray studies is so rare as to constitute the exception that proves the rule.

In the absence of the typical roentgenogram, other causes of diarrhea must be considered and ruled out such as thyrogenic diarrhea with its greatly heightened basal metabolism rate, the gastrogenic diarrhea of achylia gastrica or of a carcinoma anywhere in the stomach or in the alimentary tract. Diarrhea due to food allergy or purely nervous or emotional diarrhea require due consideration in evaluating intestinal hypermotility. Hence it is essential to get a complete personal history of each patient.

The greatest difficulty arises in differentiating cases of non-tropical sprue from instances of high regional enteritis. The roentgenographic picture in sprue is not characteristic or constant and consists of puddling and delays in higher loops of the ileum and the jejunum without constant anatomical deformities. The stools of patients with sprue are characteristically frothy and abundant and do not, as in ileitis, show a constant positive test for occult blood. Anemia is most severe and often of a

hyperchromic type, the glossitis typical and the signs of an avitaminosis more likely to be present.

In enteritis, or high ileitis, the process usually is only an extension upward of a similar granuloma of the terminal ileum. The roentgenographic defect is structural and constant and the stools are more purulent and more often contain gross or occult blood.

If the physician be given a characteristic or a suggestive roentgenogram of an ileal defect knows the age of the patient and the protracted clinical course, there will be need for consideration of only very few differentiating conditions. Angiodysplasia and multiple sarcinomatosis of the small intestine are extremely rare in comparison with ileitis. Both of these diseases occupy by predilection higher sites in the small intestine than the terminal ileum. They both may give rise to profuse, gross hemorrhages in the intestinal tract a symptom which is unusual in ileitis.

In one case all differentiating signs failed. In a patient with a typical case history suggestive of all the classical signs of ileitis, except the fistulas, but with the characteristic roentgenogram, resection was done. The pathological examination surprisingly disclosed the terminal ileum occupied by a small infiltrating argentophilic carcinoid tumor.

In the past, most cases of ileitis were erroneously called primary intestinal tuberculosis. If such a condition exists as tuberculosis of the intestinal tract, independent of tuberculosis elsewhere as in the lungs, glands, pleura, joints, etc., then it is so rare that it fails to warrant the confusion it has originated. In a complete survey of all the postmortem and surgical, pathological material in Mt. Sinai Hospital, representing a vast accumulation over the last 15 years, only 4 cases of primary intestinal tuberculosis survived a critical analysis. In 2 of these patients the ileum was the site of a mucosal lesion with typical miliary tubercles and the tubercle bacilli were found in the intestinal lesions and nowhere else in the body. These 2 cases can not be denied and might have been confused with ileitis. All other cases of intestinal tuberculosis were traceable and were secondary to a primary focus elsewhere in the body.

## TREATMENT

Regarding medical treatment, it can be said that apart from a non-roughage diet and general supportive measures nothing can be done to help the patient with ileitis. A direct therapeutic attack, in the absence of knowledge regarding the etiology, is impossible. In the cases of diffuse, almost universal involvement of the small intestine, one is forced to use medical means alone since the widespread anatomical distribution defies surgical measures. Surprisingly, these cases sometimes seem to improve under such simple measures, at least for the time being. Two such cases of diffuse ileojejunitis in which patients were not operated upon have been under observation for several years. One patient has gained as many as 50 pounds in weight under simple non-roughage diet and paregoric. The latest x-ray studies continue to show the lesion, but the general well-being of patient and inutility of surgery encourage further expectancy.

Surgery is the treatment of choice in all except acute cases of ileitis, and resection is probably the procedure which offers the best chance of permanent cure. I have no serious quarrel with any surgeon who prefers a short-circuiting operation to resection because of its lower risk, that is, 10.5 per cent, provided he understand that the patient has only an even chance of cure by this more conservative procedure. The notes of the 20 cases in which a short-circuiting operation had been performed, usually an ileocolostomy with transection and exclusion of the diseased ileum, disclosed the fact that exactly one-half or 10 patients are apparently well after a follow-up of 2 to 3 years. The 10 other patients did badly and had to submit to subsequent resection with a considerably higher, operative mortality. A primary resection can be undertaken with a moderate but not inconsiderable mortality, the rate being 15 per cent of 52 resections, but it offers the greater chance for permanent cure.

Unfortunately, one can no longer deny a certain percentage of recurrences even after what seems to have been a radical and sufficient resection (15, 19). The proportion at Mt Sinai Hospital has been 3 cases out of 39

operated upon, or 7.7 per cent. These recurrences can be explained only on 1 basis, namely, the inability of the surgeon to recognize the upper limit of mucosal involvement. Perhaps the enlarged mesenteric lymph nodes are not an infallible guide to the extent of the lesion; perhaps the advanced upper limit of infiltration is so minimal and so restricted to the mucosa as to create no hyperemic or inflammatory reaction in the serosa, thus defying detection by either inspection or palpation. We know that skip areas may leave as many as 12 to 18 inches of free uninvolved mucosa between minimal areas of diseased tissue. Recognition of these facts, and a most meticulous search of the entire ileum at the time of exploration may diminish or eliminate the chances of recurrence and lead to still greater improvement in an otherwise eminently satisfactory field of surgical endeavor.

## REFERENCES

- 1 BROWN, P. W., BARGEN, A. J., and WEBER, H. M. Proc Staff Meet Mayo Clinic, 1934, 9:331
- 2 CLUTE, H. M. Surg Clin N America, 1933, 13:561.
- 3 COLP, R. Surg Clin N America, 1934, 14:443
- 4 CROHN, B. B., GINZBURG, L., and OPPENHEIMER, G. D. J Am M Ass, 1932, 99:323
- 5 CROHN, B. B., and ROSENAK, B. J Am M Ass, 1936, 106:1
- 6 CROHN, B. B. Am J Diges Dis and Nutr, April, 1934, 1:97
- 7 Idem. Tr Am Proctol Ass, 1937.
- 8 CROHN, B. B. and PENNER, A. Ann Surg, 1938, 108:867
- 9 FELSEN, J. Am J Digest Dis and Nutr, 1935, 1:782
- 10 Idem. Am J Roentgenol, 1937, 37:190
- 11 HARRIS, F. L., BELL, G. H., and BRUNN, H. Surg, Gynec & Obst, 1933, 57:637
- 12 HOMANS, J., and HASS, G. M. New England J Med, 1933, 209:1315
- 13 KANTOR, J. L. J Am M Ass, 1934, 103:2016
- 14 KOSTER, H., KASMAN, L. P., and SCHEINFELD, W. Arch Surg, 1936, 32:789
- 15 LEWISOHN, R. Surg, Gynec & Obst, 1938, 66:215.
- 16 MIXTER, C. G. Ann Surg, 1935, 102:674
- 17 MOCK, H. F. Surg, Gynec & Obst, 1931, 41:672
- 18 MOSCHCOWITZ, E., and WILENSKY, A. O. J Med Sc, 1923, 166:48
- 19 OPPENHEIMER, G. D. J Am M Ass, 1938, 110:1103
- 20 PROBSTEN, J. G., and GRUENFELD, G. F. Ann Surg, 1936, 103:273
- 21 REICHERT, F. L., and MATHERS, M. E. Ann Surg, 1936, 104:601
- 22 SNAPPER, I. Pseudotuberculosis in man. Amsterdam, Holland, 1938
- 23 Idem. An de med, 1936, 39:1
- 24 SPROUL, Am J Roentgenol, 1936, 36:910
- 25 TIETZE, A. Ueber entzündliche Dickdarmgeschwulste. Ergebn d Chir u Orthop, 1920, 12:211

## REGIONAL ENTERITIS

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FOR many years reports of benign non-specific intestinal granulomas have appeared in medical literature but no attempt had been made to classify these lesions until 1932 when Crohn, Ginzburg and Oppenheimer segregated from the general group of granulomas one having apparently definite clinical and pathological characteristics. Their experience was based on a series of 14 cases, in every instance of which the pathological process was sharply limited to the lower segment of the small bowel. In 13 of these cases a pathological study of the resected specimens showed a chronic inflammatory process with apparent limitation of the distal progress of the lesion by the ileocecal valve. On this basis they created a clinical and pathological entity which they termed regional ileitis.

The stimulus of this first communication is evidenced by the voluminous bibliography that has accumulated in the intervening 6 years. It soon became evident that the term regional ileitis was not sufficiently comprehensive, because of increasing reports of cases showing extension of the process to the colon and proximal small intestine either by continuity or with intervening areas of apparently normal intestine. Even massive involvement, extending from the ileocecal valve to the ligament of Treitz has been encountered. For this reason the term, "regional ileitis," has been generally supplanted by the term, "regional enteritis," or "chronic cicatrizing enteritis."

The salient clinical and pathological features of the disease are as follows. It is a disease of youth. Fifty-five per cent of our 20 cases were under 25 years of age and 18 were less than 35 (9). The cause is unknown. Primary infection of the appendix spreading to the ileum (4), bacillary dysentery (2), and a possible relationship to lymphogranuloma

inguinale (12) have been suggested. A superficial resemblance between me-enteric lymphadenitis and regional enteritis (5) has led to the supposition that both may possibly be due to a low grade primary infection of the lymphatic system. Although cultures from the lesion are usually either sterile or mixed, there are several reports in the literature of the isolation of a streptococcus (8, 10). In 2 of our less advanced cases an anaerobic streptococcus was obtained in pure culture from the free peritoneal fluid and from the cut surface of the mesenteric glands. However, we have been unable to reproduce the lesion in animals with this organism. Stagnation at the ileocecal valve and bacterial absorption through the rich lymphatic supply at the ileocecal angle have been considered accountable for the greater frequency of involvement of the terminal ileum (11). In no case has the tubercle bacillus been demonstrated.

The clinical features of regional enteritis are those of a low grade inflammatory lesion of the intestinal tract, often of months' or years' duration. The signs and symptoms depend on the location, extent, duration and severity of the process. The disease is progressive, though at times marked by remissions and exacerbations. Long latent periods may occur. Although spontaneous cure may take place, the definite establishment of this contention has yet to be confirmed by a long period of observation or by pathological demonstration in operatively proved cases.

The different stages of the disease are not sharply defined, but the 4 clinical phases described by Crohn and his co-workers have been generally accepted by subsequent observers. In the first phase the symptoms and signs are those of peritoneal irritation, namely, pain in the right lower quadrant, fever, leucocytosis, tenderness, and spasm. In this stage that has so often been erroneously diagnosed as acute appendicitis and in which operation has disclosed an edematous injected loop of terminal ileum with edema and hyper

plastic adenopathy of the mesentery and an excess of free peritoneal fluid. The appendix is not involved. Little opportunity for pathological study of this stage has been afforded as surgeons have felt that resection was not warranted in most instances.

The next step in the progress of the disease is the onset of symptoms suggestive of a mild ulcerative colitis: cramp-like abdominal pain, frequent loose bowel movements with mucus and rarely a small amount of blood, bouts of fever, weakness, and generally a marked loss of weight. There is low abdominal tenderness, and a mass may be palpated. Unlike colitis, tenesmus is absent and no ulcerations are disclosed on proctoscopic examination. Anemia and leucocytosis are commonly present. Perianal lesions, such as abscesses or fistulas, are not infrequently noted.

At this time the diseased segment appears thickened and edematous but less injected, and the serosal surface is granular and somewhat suggestive of miliary tuberculosis, though the nodules do not tend to bleed as readily. The mesentery is much thickened and the adenopathy is extreme. There is a tendency of the affected loop to agglutinate to surrounding structures.

On opening the resected specimen one is struck by the thickening of the intestinal wall, the definition of its layers due to edema especially of the submucosal layer. Numerous mucosal ulcerations appear particularly along the line of the mesenteric attachment. The lesion gradually shades off into normal bowel as it is followed orally from the ileocecal valve; but at times another area of disease may be found separated from the original lesion by an intervening segment of normal ileum.

The third stage is that of chronic partial intestinal obstruction. Severe colicky pain, distention, nausea and vomiting are present. Constipation may replace the previous diarrhea, but complete obstruction very rarely occurs. A mass is almost always palpable.

The diseased bowel is rigid and hose-like and the wall is tremendously thickened with consequent encroachment on the lumen. The mucosa has a cobble-stone appearance, the healing and contracture of the ulcerations

throwing intervening areas of uninvolved mucosa into prominence. An extreme degree of this condition produces polypoid masses that further obstruct the stenosed intestinal lumen. Above the stenotic area the lumen of the bowel is dilated but gradually diminishes with decreasing abnormality of its wall and lessening of the mesenteric edema. A complete return to normal intestine may be reached only several feet above the area of greatest activity.

There is a tendency to the formation of sinuses and fistulas in regional enteritis and such complications form the fourth phase. They are the result of slow perforation of the mucosal ulcers. Acute perforation is of extreme rarity and has occurred only in the upper small bowel in reported cases. One such instance appears in our series. Slow perforation of an ulcer at the mesenteric attachment may take place with the formation of a blind sinus or an abscess between the leaves of the mesentery or adjacent intestinal coils. As the diseased loop tends to adhere to adjacent structures, perforation of the ulcers may lead to internal fistulas, commonly to the cecum and ascending colon, then to the sigmoid, transverse colon, other loops of the small intestine, and occasionally to the bladder. Persistent draining sinuses, usually in the scar of a previous appendectomy incision, are not uncommon. At times numerous surgical attempts to close such sinuses have failed until resection of the underlying diseased bowel has been done.

Much stress has been laid on the value of roentgenographic examination in the diagnosis of regional enteritis. In the early development of the lesion no abnormality will be revealed but only the inconclusive evidence of hypermotility of the bowel, perhaps accompanied by cecal spasm. As the disease advances to the obstructive form, a definite filling defect in the ileum is observed with proximal stasis and dilatation. Increasing stenosis diminishes the bowel lumen until only a fine line of barium, the "string sign" of Kantor, is seen leading to the ileocecal valve. The string sign is not pathognomic but is extremely suggestive of the diagnosis. In our experience intestinal films taken at hourly intervals furnish the most accurate data. The

barium enema will at times demonstrate a positive string sign and is helpful in defining internal fistulas and pressure defects on the colon from abscesses or agglutinated masses of the small bowel.

No attempt will be made to discuss the differential diagnosis, but it should be emphasized that regional enteritis should always be considered when a young adult complains of symptoms of partial intestinal obstruction accompanied by the signs of a low grade inflammatory process. A somewhat prolonged history of colic like abdominal pain, irregular bowel habit, loss of weight, slight fever, and leucocytosis, is highly suggestive. Distention, a palpable mass on abdominal or rectal examination and the demonstration of the string sign on x ray investigation confirm the diagnosis.

The time has been too short and the number of cases observed too few in any one clinic to permit the establishment of a fixed policy in the treatment of regional enteritis in its different stages. In the hope of obtaining information that would be of value in setting up a general technique of management, a questionnaire was sent to a limited number of clinics and surgeons in the United States. Thirty seven answers have been received and the data on 363 cases have been submitted for analysis from 31 individuals or clinics. The 6 other replies state that no instances of regional enteritis had been encountered. Only pathologically or operatively proved cases have been included in the series evaluated below. The follow up period has ranged from a few months to over 6 years, the majority having been observed for longer than 1 year. The largest single series was that of Crohn, 77 cases with operation in a total of 110 cases personally followed.

The adequate appraisal of the results of treatment be it medical or surgical, demands definite criteria by which the presence of persistent or recurrent disease may be determined. Obviously the return of persistent diarrhea, fever, and weight loss mean renewed activity of the lesion. However, many patients who have been restored to normal efficiency subsequent to radical surgical treatment, give evidence of some degree of hyper

motility of the bowel by x ray and by the passage of 2 or 3 semi formed or loose bowel movements a day. They have gained in weight and consider themselves well.

The presence of hypermotility is not in itself evidence of recurrence. Massive small intestinal resections for lesions other than regional enteritis may be followed by persistent hypermotility, for example.

A 38 year old man had an extensive small bowel resection for mesenteric venous thrombosis. Between 4 and 5 feet of gangrenous small bowel were removed. At the present time he is in good health attends to his profession as lawyer but passes an average of 3 loose stool daily. An x ray examination 18 months after operation showed marked hypermotility and moderate dilatation of the distal loops of the ileum.

From a detailed review of 257 cases of massive resection of the small bowel Haymond concluded that diarrhea was the most common and distressing postoperative disturbance. Consequently, a diagnosis of recurrence of regional enteritis should rest not only upon the evidence of hypermotility but also on the presence of bouts of fever, persistent diarrhea and loss of weight characteristic of the disease.

Of the 363 cases gathered by our questionnaire 278 have been subjected to major surgical procedures, and the total surgical mortality has been 1.2 per cent. Twenty five of the 27 surgeons who operated upon these patients consider radical resection in one or more stages as the treatment of choice in all but the earliest phase of the disease.

Although radical resection of the diseased bowel has been the most widely practiced surgical measure, the follow up studies show a very considerable percentage of recurrences. Koster, Kasman, and Sheinfeld reported 1.2 per cent of recurrences in 126 cases collected from the literature. Analysis of the material placed at our disposal shows a 20 per cent recurrence in the entire group in which operation was done. These recurrences appeared within periods varying from 4 months to 6 years. As one would surmise there is a far greater liability to recurrence in the advanced stages, so that it is clear that the optimum time for surgical intervention is in the earlier period. Comparison of the statistics of medical and surgical treatment is manifestly

meaningless as patients presented for resection in most instances have progressed unfavorably under previous medical supervision. Furthermore, medically treated patients are not necessarily proved cases of the disease,

The treatment of regional enteritis can be best considered for each of its clinical stages. Surgical intervention in the acute stage is generally conceded to be unwise. Spontaneous resolution may occur. The danger of disseminating an acute infection by operative handling is possible. When the abdomen is opened under an erroneous diagnosis and acute regional enteritis is encountered, incidental appendectomy should not be performed. Although in the past we have been guilty of this procedure in a few instances in our series at the Beth Israel Hospital, it is unsound to remove an appendix that is not implicated as a causative factor in the disease, in the presence of an acute infection. In addition, the risk of establishing an external fistula is great in a disease characterized by its tendency to fistula formation. The considerable number of patients presenting themselves with fistulas, frequently fecal in character and following a previous unnecessary appendectomy, is good evidence of this danger.

Accepting conservative measures as the preferable method of treatment in the acute stage, the progressive tendency of the disease must be kept constantly in mind. A strict medical regimen must be maintained with sufficient rest and a bland diet. If, after an adequate trial of from 3 to 6 months, the patient's condition continues to deteriorate, or should the signs of obstruction or other complications appear, a surgical approach should be considered.

There are no clearly defined boundaries between the clinical stages of regional enteritis; one phase merges gradually into another. Thus, early in the second or ulcerative stage where slight fibrotic changes have occurred, it is possible that complete regression to normal may spontaneously take place. But late in the same stage when infiltrating fibrosis has rendered the bowel rigid and inelastic and when encroachment on the lumen is already considerable though insufficient to produce

obstructive symptoms, it is hardly conceivable that restitution to normal can occur. If medical measures have failed to halt the progress of the lesion thus far, obstruction or fistula formation may be expected to follow. Surgical intervention should be employed before such developments take place.

In this stage the indications for radical resection are marked fibrotic changes in the intestinal wall and extensive mesenteric adenopathy. A wide excision of the diseased bowel and its mesentery, preferably in one stage, gives excellent results. We believe that the importance of an extensive excision of the involved mesentery should be emphasized, as it is possible that insufficient removal may be responsible for recurrence when the intestinal resection has appeared adequate. For this reason we consider resection and anastomosis preferable to a Mikulicz procedure in dealing with this condition.

The treatment of the advanced stages of the disease is unquestionably surgical. Graded procedures may be necessary. The patients are debilitated, and in the latest stages nutritional disturbances such as peripheral edema, neuritis, and anemia are often present. The common complications of abscess and fistula usually do not lend themselves safely to primary resection.

Obstruction, when present, is rarely complete and with appropriate pre-operative preparation a lateral anastomosis for its relief is usually permissible, though occasionally a preliminary ileostomy is indicated. The stoma should be placed well away from the upper limit of the lesion but an anastomosis in continuity should be avoided if possible. An unexpected delay in the performance of the resection may give the disease an opportunity to progress upward beyond the anastomosis and implicate the proximal intestine. As a curative measure the short circuiting procedures have never proved successful in our hands but apparently have been in the hands of others. However, the expression of opinion we have received is so strongly in favor of extirpation of the lesion that anastomosis must be considered merely a step toward the ultimate resection, when the patient's condition warrants the major procedure.

Fistulas commonly form between the terminal ileum and the cecum or ascending colon, and in this location can be readily dealt with at the time of the resection. When the fistula runs to the sigmoid it is not unusual to observe some evidence of the disease in the large bowel in this area. The wall is injected, somewhat thickened, and the serosa is granular. The sigmoid mesentery does not show the edema and adenopathy that is present in the mesentery of the ileum. Resection of the sigmoid is not necessary, and the lesion may be expected to subside following simple closure of the fistulous opening. Bladder fistulas, though of rare occurrence, may be similarly treated.

In a limited experience with the surgical treatment of multiple lesions involving the ileum and the sigmoid, the results have been far from satisfactory.

One patient following graded resections of both lesions showed gratifying improvement for 5 months. She then developed a fulminating recurrence with severe diarrhea. An end ileostomy was performed in a desperate attempt to afford relief. She died of peritonitis on the fourth postoperative day and at autopsy 4 perforations of the jejunum were found. There was massive involvement of the small bowel and of the colon to a lesser degree.

Lesions high in the small bowel appear to present the most virulent characteristics and it is in this situation that acute perforations into the free abdominal cavity occur. From our experience and that of others reported in the literature it would seem wise when possible, to avoid surgery in such cases.

#### SUMMARY

Much remains to be learned about regional enteritis. The etiology must be ascertained and the life history of the disease must be adequately traced. Unquestionably with advancing knowledge, our conception of the proper treatment will alter. At the present time it would appear that medical management is indicated in the acute stage of the disease. With continued progression in spite of an adequate period of intensive medical therapy radical surgical resection in one or more stages should be instituted. The outlook for restitution of health and prolonged arrest

or cure of the disease is good. Although it is impossible to state the actual number of cures in this series because of the wide variation in the period of follow up, it is evident from a study of the answers to our questionnaire that the operative mortality in the more complicated cases was much higher than in the simple or less complicated ones, and it is obvious that persistence in conservative therapy in these latter groups will work to the disadvantage of the patient.

The treatment of the advanced stages of the disease with obstructive abscess or fistula, is clearly surgical. Multiple stage procedures should be utilized, the final objective always being the resection of the involved bowel. The patient's condition is frequently precarious and a high mortality must be faced. It must be recognized also that the chance of recurrence is far greater than when dealing with the less advanced lesion. Nevertheless as the patient's progress is persistently downward and medical measures are futile, operation should be advised as offering the only opportunity for a return to health.

I wish to express my thanks for the co-operation and work required by the surgeons who kindly answered my questionnaire.

#### REFERENCES

1. CROWY B. B., GREENBERG I. and OPIEWEHNER G. D. Regional ileitis: pathologic and clinical entity. *J. Am. M. Ass.* 1932 99 1322-1329.
2. FEE R. J. and GORENBERG H. Chronic dysentery, distal ileitis and ulcerative colitis: a follow up of the Jersey City epidemic of bacillary dysentery. *Am. J. M. Sc.* 1936 192 553-556.
3. HAYMOND H. E. Massive resection of small intestine. *etc. Surg. Gynec. & Obst.* 1935 61 693.
4. HOMANS J. and HASS G. M. Regional ileitis: a clinical not a pathological entity. *New England J. Med.* 1933 209 1313-1314.
5. JACKSON A. S. Regional enteritis. *Surg. Gynec. & Obst.* 1937 65 1-10.
6. KANTOR J. L. Regional (terminal) ileitis: its roentgen diagnosis. *J. Am. M. Ass.* 1934 103 2016-2021.
7. KOTLER H., KASMAN L. P. and SHREVEFIELD W. Regional ileitis. *Arch. Surg.* 1936 33 789.
8. MAILLER R. Acute regional ileitis. *etc. Brit. J. Surg.* 1938 25 517.
9. MEXTER C. G. and STARR A. Further experience with regional enteritis. *New England J. Med.* 1938 219 37-40.
10. MEXTER C. G. Regional ileitis. *Ann. Surg.* 1935 102 674-694.
11. ISROSTREIN J. L. and GREENFIELD G. E. Acute regional ileitis. *Ann. Surg.* 1936 103 273.
12. STRATFORD E. S. Regional ileitis and ulcerative colitis. *Bull. Johns Hopkins Hosp. Balt.* 1938 67 399-407.

# THE MEDICAL TREATMENT OF BRONCHIECTASIS

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**I**N the study of pulmonary lesions it is absolutely necessary to have a correct diagnosis. Before the use of iodized oils, statistics on bronchiectasis were misleading because many cures which were reported by bronchoscopic drainage and various drugs and operations were due to spontaneous cures of lung abscesses, chronic pneumonitis or even fungus diseases of the lungs. A positive diagnosis can now be made by proper instillation of iodized oils into the bronchial tree. Then and then only, can we be sure as to whether bronchiectasis is present or not.

In the neglected cases of bronchiectasis one frequently finds that the evidence of metastatic abscess in the brain or kidney and even amyloidosis overshadows the underlying pathology. Obviously, treatment must be applied to the bronchiectatic condition as well as to the other organs. Unfortunately, when these severe complications are present little can be accomplished by any form of treatment.

In the bronchiectasis found developing in children after measles or whooping cough, occasionally the condition clears spontaneously, particularly if the lesion is not present too long. The foreign body lesions frequently heal when the foreign body is either coughed up or removed bronchoscopically.

Before specific medical treatments are described it seems advisable to discuss the various types of bronchiectasis, the etiological factors, and clinical features.

## TYPES OF BRONCHIECTASIS

There are two main types of bronchiectasis, universal and telangiectatic. The universal type is a general form which is said to affect an entire bronchus, while the telangiectatic form is the conversion of the lung as a whole, or in part, into a mass of cysts lined with light epithelium. In the latter form cysts some-

times occupy the entire chest cavity, and it is difficult to differentiate the condition from a spontaneous pneumothorax.

In the acquired form of bronchiectasis the disease is usually secondary to infection following inhalation of a foreign body into the bronchial tree, or the condition may follow the pneumonias associated with the exanthematous diseases.

Tuberculosis is frequently a precursor of dilatations of the bronchi. This is usually due to the fibrosis resulting in stenosis of some of the bronchi followed by infection and secondary dilatations. The physical changes in the lung are due, however, more to mechanical causes than infection. Mediastinal swellings, compression of the lung by fluid or by tumors, may secondarily produce bronchiectasis of irregular shapes. Tumors within the bronchi frequently act like foreign bodies and produce similar dilatations of the bronchi beyond the obstruction.

David T. Smith suggests that bronchiectasis could be produced by lesions associated with fusospirochetal infection. He states that the elastic tissue of the finer bronchi is weakened and may even rupture by the action of an aerobic group of organisms.

The age of the patient, the duration of the disease, acute exacerbations of infection, the physical state of the patient, particularly the condition of the upper respiratory tract, and also the condition of the heart, kidneys, and so forth, are important factors to be considered in a discussion of treatment.

## CLINICAL FEATURES

Nearly all cases of bronchiectasis are more or less associated with pulmonary abscess. The duration of the disease is usually of many years' standing in adults and one can frequently trace the origin in most cases to pulmonary diseases in childhood or even infancy.

The complaints are not typical. The secondary complications, such as bronchitis, abscess, or pleuritic involvement, are the

From the Chest Service, Cedars of Lebanon Hospital. Presented before the Clinical Congress of the American College of Surgeons, October 17-21, 1938. A paper presenting the "Surgical Treatment of Bronchiectasis" was read by Norman S. Shenstone and has been published elsewhere.



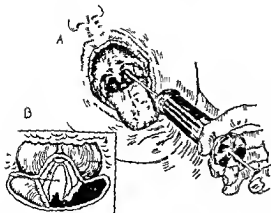


Fig 1 A Aspiration method of injecting lipiodol. Note the straight cannula placed between the uvula and the tonsil. B The oil is shown filling the inner arytenoid fossa and dripping into the larynx when the patient takes a deep breath.

symptoms which call for attention. Cough is the most important and frequent complaint. It is usually severe and persistent during a great part of the day and night. The secretion brought up varies in amount from a few cubic centimeters to 800 or 1000 cubic centimeters. It may be foul or bloody. At times the expectoration is so foul that it is not only disgusting to the family but to the patient himself. Fever, sweats, and chills are frequently associated with the disease but only when secondary abscesses are present. It is not unusual for recurrent attacks of so called pneumonitis to develop which in time may be followed by metastatic abscess of the brain, kidney, and in late stages with amyloidosis. Many patients have hypertrophic osteoarthropathy (club nails) particularly if the condition is of long standing.

The physical findings are vague in the chest. At times râles are present in one or both lower lobes. The character of these varies with the amount of secretion. Dullness on percussion is rare but increased whisper signs over the affected area may be the diagnostic sign. If drainage is accomplished by position, the increased whisper sounds are particularly loud.

It is the roentgenographic study of the lungs which establishes the diagnosis positively, particularly when iodized oil is injected into the bronchial tree. This can be

done easily. The patient faces a good light and is told to open his mouth as widely as possible, his tongue is grasped with a piece of gauze and is pulled out as far as possible. Iodized oil, which has previously been warmed in a syringe, is slowly injected into the post pharynx through a straight cannula while the patient breathes deeply. The patient is instructed not to swallow or cough during the injection. Local anesthesia is seldom necessary although in nervous patients it is advisable to use 1 per cent procaine as a spray to the pharynx. The roentgenogram after injection shows the various types of dilatation.

#### TREATMENT

It is quite evident from the descriptions given that no definite or specific treatment can be used for such a complex condition of bronchiectasis. A cure can be effected only when the diseased portion of the lung or the entire lung, if it is unusually involved, is removed surgically.

Much can be done, however, to relieve the symptoms which at times are most distressing. It should be appreciated that the infection of the bronchiectatic areas sometimes becomes quiescent and the symptoms of cough and expectoration disappear. The patient, and sometimes the physician, may think the patient is well although in many such cases the introduction of the iodized oil into the bronchi will demonstrate the presence of the dilatation just as before the so called cure.

Among the medical treatments suggested for bronchiectasis are the following: rest, diet, climate, postural drainage, thirst cure, heliotherapy, intravenous therapy, direct intra bronchial application of drugs, irrigation of the lung (bronchial lavage), inhalation of vapors, vaccine therapy, bronchoscopy, artificial pneumothorax, abdominal belts and oleothorax. So many treatments are offered but none of them has really done much to cure the patient, but the symptoms have been much ameliorated.

**Rest.** As in most pulmonary diseases, rest is an essential part of the treatment. The healing factors of the body are best able to function when there is freedom from exercise and work. It has been shown by Pritchard

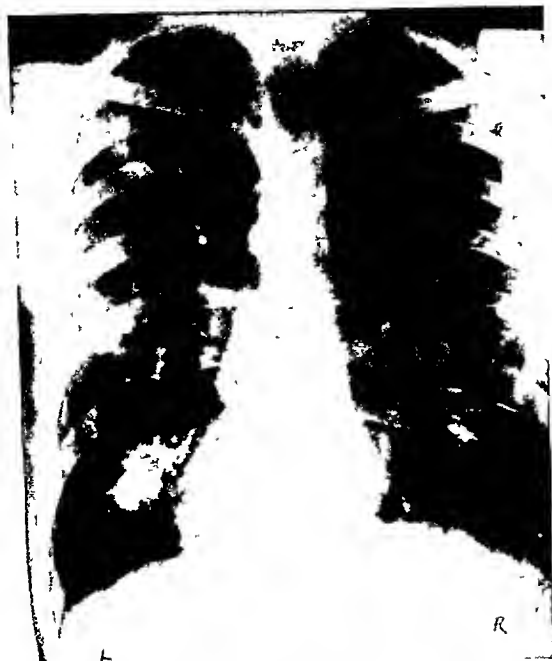


Fig 2 Roentgenogram of a patient with bilateral bronchiectasis. One can see some irregular densities in both bases and hilar regions (See Fig 3)

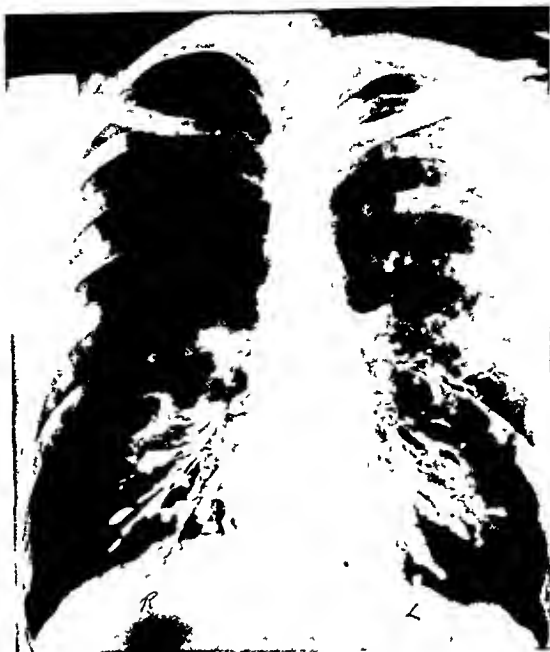


Fig 3 After lipiodol injection one notes the true condition of cylindrical and clubbing bronchiectasis of both lungs. Without the oil no definite conclusion could be had concerning the pathological condition of the lungs.

that when patients with bronchiectasis are put to bed they cough less, gain weight and are generally better. The rest need not be as strict as in tuberculosis. Even when strict and prolonged, rest alone will not cure bronchiectasis.

**Diet** Diet should be simple and sufficient to provide caloric requirements which are increased whenever there is fever. No specific restrictions are indicated. Care should be taken to provide an adequate protein and vitamin intake. Vitamins may play an important part but as yet nothing definite has been proved of value in this disease.

**Climate** Close study of accumulated experience suggests that climate alone never cured bronchiectasis. It is undoubtedly true, however, that temporary, and in some cases, long lasting improvement results from change in climate. Some patients have apparently benefited from the dry, sunny climates of Arizona and New Mexico; others from the mountains or the seashore. In resistant cases, the desirable effects of climate should be tried whenever economic conditions permit.

**Postural drainage** Of all the measures for symptomatic relief, postural drainage is the most effective. While the method is simple,

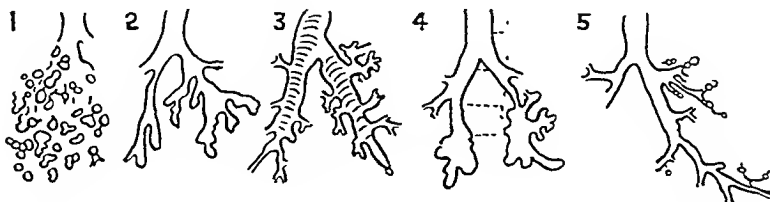


Fig 4 Classification of bronchiectasis. 1, grape, 2, clubbing, 3, cylindrical, 4, sac, 5, bead formation (From Ballon, Arch Surg, 1927, p 184)

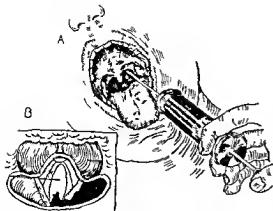


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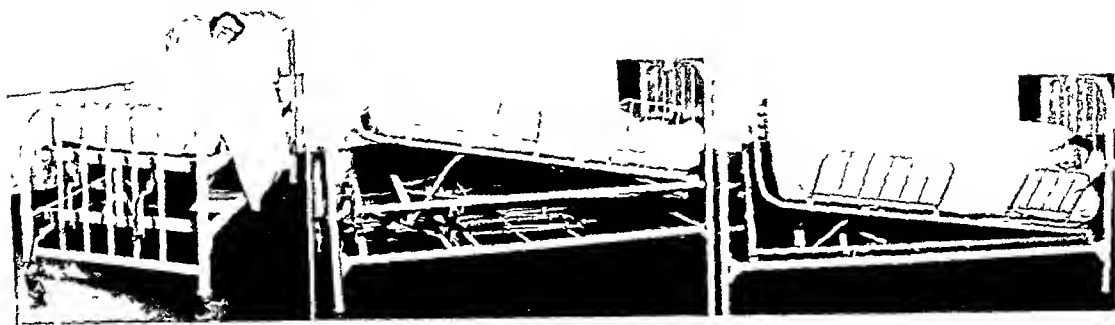


Fig 6 Postural drainage bed (Singer) found useful for patients who are too ill for the drainage table, and for postoperative positioning. The various positions are obtained by turning appropriate levers.

that the iodine content does not separate from the oil except in the gastro-intestinal tract where it is slowly absorbed and the iodine is eliminated through the kidneys. There is nothing in the iodized oil which prohibits the growth of bacteria. In fact it has been shown that the oil on agar plates does not prevent the growth of adjoining colonies of *Bacillus coli*, *Staphylococcus aureus* and *Streptococcus hemolyticus*.

Since the iodized oils are not bacteriostatic, little effect might be expected from the introduction of 20 cubic centimeters of oil every 2 weeks. The effect of the oil is due to its weight which permits it to cover the bronchial walls with a coating of oil. This may, in a measure, prevent irritation of the mucous membrane by retained pus and organisms. It tends also to liquefy and to dilute the secretions so that in coughing the discharge is more easily expectorated.

There are certain patients who have an idiosyncrasy for iodine or bromine in any form, and it is always advisable to find out whether such a condition exists before the introduction of these oils into the lung. In these patients even a small amount of the oil may produce coryza, increased cough, and feeling of malaise. The oil should not be injected more often than once a week and the amount should vary between 10 and 20 cubic centimeters. It should be warmed to body heat before its introduction and should be introduced with the least possible mechanical disturbance. If one does not obtain good and positive results within 3 or 4 weeks, it is not advisable to continue the treatment.

*Bronchial irrigation (lavage)* This method of treatment has been suggested as far back as 1914 by Yankauer. It was done through a bronchoscope or by a soft rubber Condé catheter. Stutt and Wooding, employing a hypertonic mixture of a saline solution, report 35 per cent symptomatic cures in a series of 250 cases. For the study of the value of bronchial irrigation, this method employed is worthwhile, but we have found, in our own experience, that postural drainage with an occasional bronchoscopic aspiration served the same purpose. With all the benefits derived from lavage, the bronchial dilations still persisted.

*Inhalations of medicated air and volatile drugs.* The inhalations are not recommended. Many physicians, however, particularly in Europe, have developed chambers containing medicated air and have recommended it to patients with bronchiectasis. It is hard to believe how any such inhalations can improve the state of the bronchial tubes.

*Vaccine therapy* The autogenous or stock vaccines made from various mixtures of bacteria, that are present in the respiratory tract, have been recommended. In our own experience this has been of very little benefit even symptomatically. There are, however, many men who have used this treatment, particularly the autogenous form of vaccine and it would be quite difficult to argue the value of such treatment with those who believe in it. But the author cannot recommend it at this time. It is possible, however, that the experimental studies may eventually bring forth a vaccine that may be of considerable benefit.

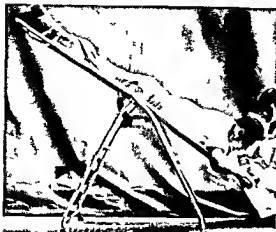


Fig 5 Postural drainage table (Simmer) made of metal tubing with a pivot and brake arrangement at center of table top. It is not necessary to tip the patient more than 3 minutes 2 or 3 times a day.

detailed directions must be given patients if the most benefit is to be obtained. By observation of their own case some patients find that considerable drainage is obtained in certain positions and they are able to relieve themselves of large quantities of purulent sputum with little difficulty. It is obvious to this type of patient that the recommendation of postural drainage tables or beds are not advisable. The simplest form of postural drainage is the use of a see saw arrangement whereby a long board is attached to a carpenter's horse and the patient inclines himself at the proper angle (Fig 5).

A postural drainage bed has also been devised by the author (Fig 6). In this bed the patient can be placed without any effort, in almost any incline for drainage. The apparatus is simple and the various positions can be obtained by moving certain levers.

Another simple means for obtaining postural drainage is by kneeling on a chair with the hands on the floor. The length of time for each drainage varies with the pulmonary conditions but usually should not be over 2 to 5 minutes at a time. If drainage is obtained easily, it should be done two or three times a day. This keeps the bronchi empty most of the time and permits many patients to go about their work and play without discomfort. Drainage before bedtime is particularly help-

ful. In many cases the benefit derived from postural drainage is dramatic and the patient frequently believes that he is cured. Improvement may be prolonged but the underlying condition is not corrected.

Of great importance is the correction of chronic upper respiratory conditions and unless these conditions are attended to, other treatment is not effective. At this point one might mention the importance of close cooperation between the otolaryngologists and the physician. The attempt on the part of the physician to treat bronchiectasis alone meets with failure if there is a lack of cooperation.

The acute exacerbation in bronchiectasis is due frequently to conditions arising in the upper respiratory tract, and any treatment directed toward this condition may prevent aggravation of a pathological state in the lung which is always present in bronchiectasis.

**Heliotherapy.** This method of treatment has been given considerable attention but so far no change in the pulmonary lesions has been noted other than the general effects obtained by sunlight.

**Intravenous therapy—nearsphenamine.** This drug is given in similar doses as in the treatment of syphilis and occasionally one sees a clearing up of symptoms, particularly in the amount of sputum which is reduced, and the fetid odor which may be present disappears. But the number of patients who have been much benefited so far are few. There are some who prefer to give nearsphenamine in minute doses frequently repeated, but observation of results leads to the conclusion that one cannot expect too much from this mode of treatment. When properly given there is no harm in the use of this drug, and it seems to be worthwhile when administered in addition to other treatments particularly postural drainage and rest. Other drugs have been tried with even less benefit.

**Intrabronchial application of drugs.** Lipiodol and other iodized and bromized oils have been recommended as a treatment for bronchiectasis. The method of introducing the oil has been described previously (4). It might be well to note that the oil is a combination of some oil with iodine, and that the mixture is a physical rather than a chemical one, and

the oil injected into the pleural cavity to test the reaction of each patient to the oil. Two hundred cubic centimeters of the oil is injected after one determines that the patient can tolerate the treatment. At the following treatment, which may be 5 or 6 days later, larger amounts can be used. It may take 6 or 7 treatments to fill the cavity but one should always leave some space for the serous exudate which usually forms. If there is fever or irritating cough, it is not advisable to continue the treatment.

Postural drainage must be used in addition to oleothorax and other hygienic measures coincident with the oil treatment.

#### SUMMARY AND CONCLUSIONS

Such pity was aroused by the hopeless outlook of many patients before bronchiectasis was made a major study, that physicians and surgeons were stimulated to find something of benefit to these patients.

Bronchiectasis is still a serious disease which baffles the profession. The manifold character of the pathological process and the wide range of symptoms make it impossible to discuss the disease generally. Each type demands appropriate discussion and treatment.

In the diagnosis of these types, infinite care must be exercised to arrive at definite conclusions. Fortunately our methods of roentgenographic examinations, our expert laboratory facilities, and our increased acumen in physical diagnosis have enabled us to sift out properly the bronchiectasis from the many pulmonary cases which formerly were usually classed as tuberculosis, abscess of the lung, or even malignancy. Probably the greatest strides thus far have been in finding suitable cases for surgical approach.

It has taken almost 20 years to have a fairly good idea of bronchiectasis, but now, with the increased interest, the next few years may even find a cure.

The careful study of the bacteriological flora has also contributed much to our knowledge of bronchiectasis. The suggestion of the use of neoparsphenamine has been based on these studies.

The detailed treatment of sinus infections along with other symptomatic treatments have also been helpful.

The use of postural drainage has kept many patients so well drained of their purulent secretions that complications have been kept down to the minimum.

The use of compression belts to give the abdominal muscles support and also to raise the diaphragm has been effective in reducing discomforts of coughing and also aiding in the expectoration.

Finally, the medical treatments, while not always effective, have improved the patient so frequently that he can stand surgical treatment.

#### REFERENCES

1. BERCK, M., and HARRIS, W. The use of roentgen therapy in bronchiectasis. *J Am M Ass*, 1937, 108: 517-522.
2. GRAHAM, E., SINGER, J. J., and BALLON, C. *Surgical Diseases of the Chest*. p 162. Philadelphia: Lea and Febiger, 1935.
3. PRITCHARD, S. Medical treatment of chronic suppurative non-tuberculosis bronchopulmonary affections. *Tr Nat Ass Prev Consumpt*, 1927, pp 222-225.
4. SINGER, J. J. A simple method of introducing iodized oil into the lungs. *J Am M Ass*, 1926, 87: 1258.
5. SMITH, DAVID T. Etiology of primary bronchiectasis. *Arch Surg*, 1930, 21: 1173.
6. STITT, H. L. Bronchial lavage. *Weekly Bull St Louis M Soc*, 1932, 26: 246.
7. WOODING, C. E. Medical aspects of bronchial lavage. *Weekly Bull St. Louis M Soc*, 1932, 26: 249.
8. YANKAUER, S. Cited by Stitt.

*Roentgen therapy* This method of treatment has been suggested by several authorities. The logic of the treatment is that the fibrosis of the lung can be produced which may in time, by the shrinking of the lung, close the bronchi and prevent puddling of secretions within them. While the clinical reports seem encouraging, it does not seem probable that a great deal of permanent good can result. In fact, when one considers that bronchiectasis is often produced by fibrosis, an uncontrolled fibrosis produced by roentgenotherapy may be just as bad as if the fibrosis was due to inflammation. Further studies with dosage and proper material may show that there is some benefit in the use of the roentgenotherapy. It is by no means a closed book. Cases described by Berck seem to have shown some improvement clinically.

*Use of the bronchoscope* The use of the bronchoscope has received considerable attention. Its value for diagnosis or for drainage of the bronchial tubes is not disputed. One of the greatest benefits derived from the use of the bronchoscope is the ability of the operator to dilate some of the bronchi and to remove some of the granulation tissue when it is within the optical field.

Whether patients have been cured by its use is another matter. There are many bronchi which cannot be aspirated, either because there is a stenosis or because they are too far away from the main stem bronchus. Therefore, the secretions retained in these areas may become inspissated with the possibility of small abscess formations. The bronchial tree can be compared to a large sponge with the inflammatory conditions narrowing bronchi here and producing dilatations there. The affected lobe or lobes are in such a physical state that drainage cannot be established from all its openings. Therefore, drainage through the bronchoscope can at best be only partially effective. One cannot expect that aspiration of pus from the bronchial dilatations will lead to cure when the bronchial walls are thickened by inflammatory tissue. The symptoms, however, are frequently relieved enough to permit the patient to carry on his daily activities. In a comparison with postural drainage, the bronchoscope may

drain out dilatations more quickly but the treatment is not a pleasant one and certainly is expensive.

In the active attempt to treat bronchiectasis with a bronchoscope, some men have gone too far particularly in the frequency and the length of time the bronchoscopic drainage has been done. It is the opinion of the writer that if no positive benefits are derived within the first few months, surgical methods should be considered in patients who are otherwise found suitable.

*Pneumothorax* Treatment by means of artificial pneumothorax has been extensively advocated, however, since the use of iodized oil has become established, the enthusiasm for this treatment has diminished. It has been found that even when the lung is well collapsed the bronchial dilatations are still present after the collapse of the lung. One might wonder how compression of a diseased lung in which there is fibrosis, with thickened and dilated bronchi, can be effective in changing these factors. It appears that the explanation of the improvements following pneumothorax treatment is based on the fact that the lung as a whole is put at rest and that as a result natural recuperative processes may become more effective. Drainage from some of the bronchi may be better as a result of a change in the direction of the bronchi by the pneumothorax. Symptomatic relief is occasionally sudden and dramatic but in the majority of instances no permanent benefit has resulted. It is customary to inject 200 to 300 cubic centimeters at a time repeated as frequently as the air is absorbed and the lung re-expands. One should discontinue treatment after a few months if definite improvement fails to manifest itself.

*Oleothorax* When there is improvement from pneumothorax or when there is difficulty in continuing the treatments, oleothorax may be instituted. In a few instances improvement has resulted when this method has been used. The lung can be kept compressed for several years.

The oil injected consists of 95 per cent liquid paraffine or olive oil to which is added 5 per cent gomenol. The treatment should be started with only a few cubic centimeters of

patient, bleeding from such an ulcer, returned not in 6 weeks but in a year

Of 44 patients, whose symptoms returned after gastric resection, only 5 were previously operated upon by me, 3 with the Billroth I, and 2 with the Hofmeister-Finsterer technique. It is interesting to note that there were 12 patients who had been operated upon by Lorenz who always did a Billroth II, resecting only the antrum

Of 19 cases with a previous radical operation for gastrojejunal ulcer 10 had a Y-shaped anastomosis according to Roux and 4 an entero-anastomosis which favors the development of a gastrojejunal ulcer. Three patients, upon whom I had previously performed a Billroth I, later required a resection for a recurrent duodenal ulcer

Repeated gastric operations are technically difficult due often to the many adhesions present. They are, therefore, attended with a higher mortality than ordinary. Of 331 patients operated upon, 39 died, or 11.7 per cent. By subtracting those cases complicated by acute perforation, acute hemorrhage, or gastrocolic fistula, the mortality rate drops to 8.6 per cent, or 299 cases with 26 deaths. Excision or closure of a perforated ulcer, pyloroplasty, sleeve resection of the stomach, or gastro-entrostomy without gastrojejunal ulcer, do not present unusual difficulties at the time of re-operation. In only 2 of 83 resections did the patient die—a mortality of 2.7 per cent.

With the radical operation for gastrojejunal ulcer following a posterior gastro-entrostomy the mortality increased to 6.8 per cent, or 116 cases with 8 deaths. This increase is due partly to the procedure of Billroth I or Hab-

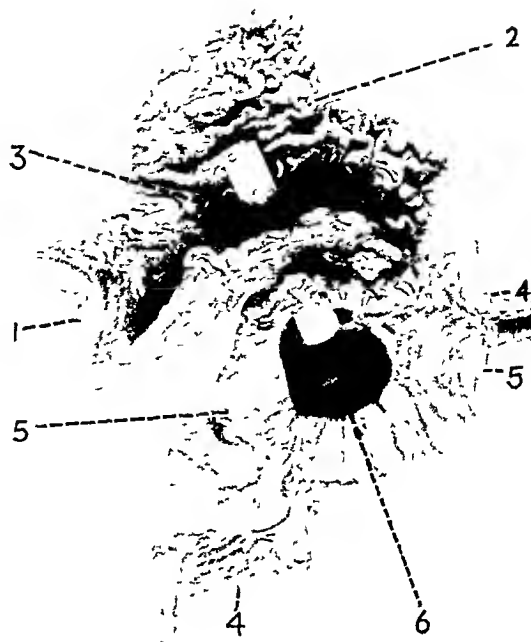


Fig 1 Gastrojejunocolic fistula 1, Duodenum, 2, lesser curvature, 3, gastro-enterostomy, 4, anastomotic loop with an introduced rubber tube, 5, resected part of the transverse colon, 6, opening of the fistula in the transverse colon

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TABLE I — PREVIOUS OPERATION

	Cases
Closing of perforation	29
Closing of perforation and gastro-entrostomy	22
Jejunostomy	2
Pyloroplasty	3
Excision of the ulcer	7
Gastro-duodenostomy	2
Gastro-entrostomy	168
Eiselsberg's pyloric exclusion	14
Sleeve resection	4
Resection for exclusion	17
Partial gastrectomy with removal of the ulcer	44
Radical operation for gastrojejunal ulcer	19
Total	331

TABLE II — MORTALITY OF RADICAL OPERATION FOR UNCOMPLICATED GASTROJEJUNAL ULCERS

	Number	Mortality	Per cent
Previous operation			
Posterior gastro-entrostomy	116	8	6.8*
Anterior gastro-entrostomy	19	3	15.7
Eiselsberg's pyloric exclusion	13	2	15.3
Resection for exclusion	5	1	20.0*
Partial gastrectomy with removal of the ulcer	29	7	24.1
Radical operation for gastrojejunal ulcer	14	3	21.4
Total	196	24	12.2

\*Mortality rate following radical operations for gastrojejunal ulcer after gastro-entrostomy is 8.1 per cent after resection 23.5 per cent



# RESULTS OF REPEATED OPERATIONS UPON THE STOMACH ESPECIALLY FOR GASTROJEJUNAL ULCERS

PROFESSOR HANS FINSTERER Vienna Austria

**M**Y experience is based upon 331 repeated stomach operations, 2,753 operations for the relief of benign gastric lesions of which 2,433 were resections. On only 39 occasions did I perform the previous operation. Table I indicates the primary operation.

Closure of a perforated ulcer is an emergency operation. An acute ulcer may heal after closure but a chronic ulcer almost never heals until it is resected. Gastro enterostomy rarely leads to permanent cure. Zuckschwerdt and Eck report cures in only 21.5 per cent with the development of a gastrojejunal ulcer in 51 per cent. Personally I have for the past 20 years resorted to gastro enterostomy only in those cases with severe pyloric stenosis in which resection of the perforated ulcer was impossible. To prevent the development of a gastrojejunal ulcer these patients are strongly urged to return in 3 months for a radical resection even though they be free from signs and symptoms.

Recently I found in a 38 year old patient who 4 months previously had had a gastro enterostomy performed in my hospital for a perforated duodenal ulcer with pyloric stenosis a large gastrojejunal ulcer about to perforate into the transverse colon. Complete recovery followed the radical resection. Two other patients who failed to report as requested finally had to be operated upon for a gastrocolic fistula despite the fact that one of them was completely symptom free after the first operation.

The commonest preceding operation performed was a gastro enterostomy. 190 cases. In 12 of these no ulcer could be demonstrated upon re operating, only chronic gastritis with a hypertrophic pyloric stenosis. It is somewhat questionable whether they ever had an ulcer. In 4 patients with normal or reduced gastric acidity the gastro enterostomy was closed and Finney's operation performed that is gastroduodenostomy with division of the

pylorus. Eight patients due to high acidity, required a resection of the pylorus and antrum according to Billroth I or Haberer.

In 23 cases the chronic ulcer still persisted, without, however, a gastrojejunal ulcer. Years ago when confronted with this type of case I resected the stomach with the duodenal ulcer 3 times, and 3 times resected the pylorus and antrum when extirpation of the ulcer was impossible, not disturbing the previous gastro enterostomy. Due to inadequate resection none of these were cured. So for the past 20 years I have been closing the gastro enterostomy and after resection of two thirds of the stomach do an end to side anastomosis between the jejunum and the remaining portion of the stomach according to the Hofmeister Finsterer technique. All of these patients have been permanently cured.

In 155 cases a gastrojejunal ulcer had formed though often the old ulcer had healed. The patients developed signs and symptoms of the new ulcer soon after the gastro enterostomy was performed. They had received medical treatment for long periods without relief one case for 27 years and another for 30 years with repeated hemorrhages.

In 8 cases of resection for exclusion of an unresectable duodenal ulcer a planned 2 stage resection was done, removing the diseased gall bladder and excluding part of the antrum with the pylorus at the second stage. This latter was comparatively easy because the penetrating ulcer had already healed with a stenotic scar. Of the 9 cases in which a gastrojejunal ulcer developed after resection for exclusion I had performed the first operation in 4 instances. The cause of the return in 3 of these was inadequate gastric resection. From 1919 to 1920, I resected only the antrum. The fourth patient because of complications with cholelithiasis was advised to return in 6 weeks for the second operation in order to prevent the formation of a gastrojejunal ulcer. The

From the First Surgical Section of the Allgemeines Krankenhaus.

Presented before the Clinical Congress of the American College of Surgeons New York October 17-21 1925

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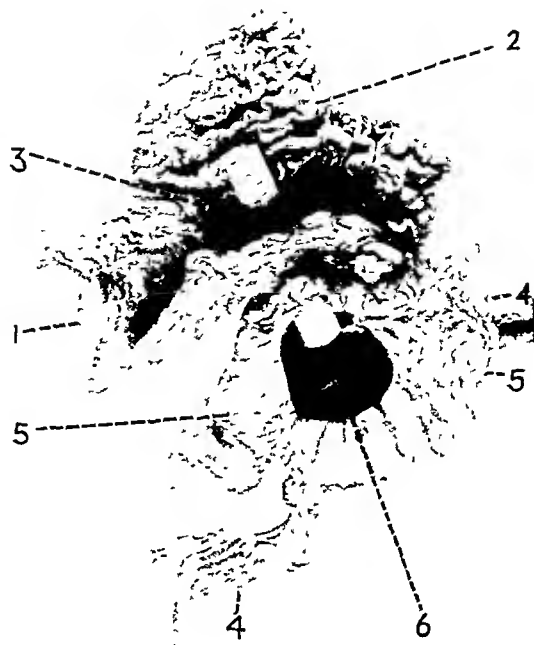


Fig. 1. Gastrojejunal ulcer. 1, Duodenum; 2, lesser curvature; 3, gastro-enterostomy; 4, anastomotic loop with an introduced rubber tube; 5, resected part of the transverse colon; 6, opening of the fistula in the transverse colon.

erer, for it has been pointed out that in 28 cases 3 deaths were not due to the resection but rather to the technique of the anastomosis: (1) peritonitis due to leakage through the line of suture; (2) acute pancreatitis caused by reflux of the duodenal content into the pancreatic duct, due to the temporary stenosis of the end-to-end anastomosis of the jejunum,

TABLE I — PREVIOUS OPERATION

	Cases
Closing of perforation	29
Closing of perforation and gastro-enterostomy	22
Jejunostomy	2
Pyloroplasty	3
Excision of the ulcer	7
Gastroduodenostomy	2
Gastro-enterostomy	168
Eiselsberg's pyloric exclusion	14
Sleeve resection	4
Resection for exclusion	17
Partial gastrectomy with removal of the ulcer	44
Radical operation for gastrojejunal ulcer	19
<b>Total</b>	<b>331</b>

TABLE II — MORTALITY OF RADICAL OPERATION FOR UNCOMPLICATED GASTROJEJUNAL ULCERS

Previous operation	Number	Mortality	Per cent
Posterior gastro-enterostomy	116	8	6.8*
Anterior gastro-enterostomy	19	3	15.7
Eiselsberg's pyloric exclusion	13	2	15.3
Resection for exclusion	5	1	20.0*
Partial gastrectomy with removal of the ulcer	29	7	24.1
Radical operation for gastrojejunal ulcer	14	3	21.4
<b>Total</b>	<b>196</b>	<b>24</b>	<b>12.2</b>

\*Mortality rate following radical operations for gastrojejunal ulcer after gastro-enterostomy is 8.1 per cent, after resection, 23.5 per cent.

and (3) death from toxemia due to occlusion of the end to end anastomosis of the jejunum. Therefore, the mortality is but 5.6 per cent, or 5 deaths in 88 cases when the radical operation for gastrojejunal ulcer after posterior gastroenterostomy is performed according to the Hofmeister Finsterer technique.

The radical operation for recurrent ulcer following gastric resection has a marked higher mortality. Seven patients with recurrent duodenal ulcer following a Billroth I, and 3 with gastritis following a Billroth II, all without a gastrojejunal ulcer, were cured by a more completely radical procedure. However, radical surgery for gastrojejunal ulcer following resection was attended with a mortality of 23.5 per cent or 8 deaths in 34 patients so treated.

Of these 8, 4 required a general anesthetic, 2 ether, one 220, another 250 cubic centimeters, and 2 nitrous oxide to supplement the local anesthesia. Two patients died of sepsis following an esophageal fistula and a left sided subphrenic abscess, 1 died of heart failure and 1 died with carcinoma of the pancreas, diagnosed at the time of operation and confirmed at autopsy. One patient, in whom difficulty was encountered when the mesocolon was sutured to the anterior wall of the stomach, vomited so strenuously after operation that he had to be re-operated upon twice. This patient finally died of pneumonia. Of the 4 deaths due to peritonitis, 1 patient had eversion of the small bowel for 9 hours before discovery and repair. This 46 year old patient had a large ventral hernia following the 2 previous laparotomies, which could not be properly repaired at the time of the third operation. The second death from peritonitis was due to infection, not, however, due to failure of the suture line.

The significant difference in the mortality rate following radical operations for gastrojejunal ulcer after gastroenterostomy, 8.1 per cent, and after resection, 23.5 per cent, should I believe, determine the indications for the management of a recurrent ulcer. Although I never hesitate to advise operation for a gastrojejunal ulcer following a gastroenterostomy in those cases in which the ulcer recurs after resection, I advise medical treatment first. If repeated courses of treatment fail despite its danger, new surgical interference is indicated.

The radical operation for a recurrent gastrojejunal ulcer is attended with a higher mortality rate not only because it is more difficult to perform, but also because the patient due to previous operations and prolonged illness,

has often become a morphine addict. Of 14 such patients 3 died, a mortality of 21.4 per cent.

A 47 year old colleague of mine, who had had 3 operations, 2 gastro enterotomies and 1 resection for a gastrojejunal ulcer with a Y shaped anastomosis, required further surgery to relieve the unendurable pain of a large penetrating gastrojejunal ulcer. This patient a morphine addict insisted upon a general anesthetic and 300 cubic centimeters of ether were administered. However the local anesthesia reduced the amount that would otherwise have been necessary. Thirty six hours after operation the patient died of cardiac failure despite the establishment of normal intestinal peristalsis.

A 29 year old patient who also had had 3 previous operations, a gastro enterostomy and 2 resections with a Y anastomosis, required surgical relief for a large penetrating ulcer. This patient died from peritonitis that developed not from seepage through the line of suture but from infection that developed as a result of the poor asepsis maintained in that operating room. The third death was due to necrosis of the wall of the stomach, for during the resection the left gastric and last branch of the gastro-epiploic arteries had to be ligated and the diaphragmatic arteries failed to provide an adequate blood supply.

A gastrocolic fistula complicating a gastrojejunal ulcer has a grave prognosis, for the patient loses weight very rapidly and may die of inanition without surgical interference. However, if such a fistula is not opposite the opening of the gastro enterostomy but is distal to it, the patient may live for many years because most of the intestinal contents will proceed through its normal course into the small bowel and not through the short circuit into the colon.

Six years ago I operated upon a 50 year old patient on whom the roentgenologist Dr. Freud 14 years previously had demonstrated the existence of a jejuno-colic fistula following a gastro enterostomy. Finally, after years of reasonable comfort, this patient sought relief for severe pains and repeated hemorrhages. A finger's width jejuno-colic fistula was found in the distal loop of the jejunum 5 centimeters distal to the gastro enterostomy where there was also a gastrojejunal ulcer. Following resection of the colon with side to side anastomosis and resection of the duodenum and two-thirds of the stomach with anastomosis according to the Hofmeister Finsterer technique, the patient completely recovered.

Gosset reports a similar case. The patient had a jejuno-colic fistula of 5 years' standing

and finally developed a gastrojejunal fistula through the perforation of a second gastrojejunal ulcer

To control inanition it is sufficient to divide the colon and anastomotic loop closing both openings. To cure the patient a radical operation must be performed later when his condition improves. If the patient's condition is satisfactory, the radical operation for jejunal ulcer can be performed immediately after separation and suture of the colon. Both methods have their disadvantages, namely, the excision of the edges of the fistula and the suturing of the same are possible only when the opening is not too large, and the new lines of suture are placed in infected tissue, which, covered with omentum, may form an abscess that can perforate into the free peritoneal cavity and cause death from peritonitis.

I had 2 deaths in 6 such cases of radical operation for gastrojejunal ulcer with suturing of the colon, one of which was really quite interesting.

A 43 year old innkeeper had had a posterior gastro-enterostomy performed 5 years previous for an acute perforated duodenal ulcer. In a short time after the operation he developed periodic pains and finally a profuse diarrhea. X-ray examination confirmed the existence of a gastrocolic fistula, and at operation a 2-fingers' width colic fistula was found with the walls of the colon infiltrated. The colon was separated from the stomach, the opening closed with 4 lines of sutures and covered with omentum, then two-thirds of the stomach with the anastomotic loop were resected and the duodenum closed blindly. An end-to-end anastomosis of the jejunum, and distally to this an end-to-side anastomosis were done according to the Hofmeister-Finsterer technique. Finally a drain was placed under the liver. At first the patient established normal peristalsis despite continuous fever suggestive of pneumonia. Suddenly on the sixteenth day he developed terrific pains on the left side of his abdomen similar to those of a perforation. Upon reopening the abdomen 5 hours later an abscess was found near the colon repair, although the suture line was intact. The peritoneal cavity and the abscess were irrigated with normal salt solution and drained. The patient expired 3 days later from spreading peritonitis. In this case it was a mistake to repair the colon without resection, a mistake to cover it with omentum, and a mistake not to extra-peritonealize and not to drain. It was impossible to save the patient after the abscess ruptured.

Thirteen patients required a radical operation for gastrojejunal ulcer and a resection of

TABLE III.—MORTALITY WITH COMPLICATED GASTROJEJUNAL ULCERS

	Number	Mortality
Gastrocolic fistula		
Radical operation for gastrojejunal ulcer and closing of the colon	6	2
Radical operation for gastrojejunal ulcer and one stage colon resection	7	3
Radical operation for gastrojejunal ulcer and two stage colon resection	6	2
Total	19	7*
Acute profuse hemorrhage		
Immediate operation (24 to 48 hours)	5	
Delayed operation (3 to 7 days)	6	4
Total	11	4*

\*Representing a total of 36.8 per cent.

\*Representing a total of 36.3 per cent.

the colon. Seven of them had a 1-stage colon resection with side-to-side anastomosis and 3 of these died.

A 63 year old man, who had been sign and symptom-free for 17 years after a gastro-enterostomy, suddenly developed a profuse diarrhea lasting 3 weeks. During the radical operation, while mobilizing the short afferent loop, the gastrojejunal ulcer perforated, infecting the operative field. Peritonitis and death followed. In a second case the peritonitis developed not as a complication of the operation or from leakage from the suture line, but from the inadequate asepsis of an unsatisfactory operating room, which manifested itself in less serious cases. The third death could have been prevented for it was a mistake to perform a one-stage resection of a colon filled with feces.

A 43 year old man, with a gastric history of 20 years' standing, 2 severe hemorrhages, a gastro-enterostomy performed 10 years previously with recurrence of periodic pains within 2 years, profuse diarrhea for 2 months and a loss of weight of 30 kilograms, presented a gastrocolic fistula. At the operation, performed on May 2, 1935, under splanchnic anesthesia, a posterior gastro-enterostomy with a large gastrojejunal ulcer, a 3-fingers' width colic fistula with proximal stenosis of the colon were found, and the ascending and transverse colon was filled with feces. With a side-to-side anastomosis, 10 centimeters of the colon were resected. Resection of the duodenum and three-fourths of the stomach with the anastomotic loop, an end-to-end anastomosis in the jejunum, closure of the duodenum, and an anterior gastro-enterostomy with entero-anastomosis were performed because of the resection of the colon. The abdomen was then closed. On the first postoperative day the pulse was 84, on the second 88 and on the

and (3) death from toxemia due to occlusion of the end to end anastomosis of the jejunum. Therefore, the mortality is but 5.6 per cent, or 5 deaths in 88 cases when the radical operation for gastrojejunal ulcer after posterior gastroenterostomy is performed according to the Hofmeister Finsterer technique.

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Of these 84 required a general anesthetic, 2 ether one 220 another 250 cubic centimeters and 2 nitrous oxide to supplement the local anesthesia. Two patients died of sepsis following an esophageal fistula and a left sided subphrenic abscess. 1 died of heart failure and 1 died with carcinoma of the pancreas diagnosed at the time of operation and confirmed at autopsy. One patient in whom difficulty was encountered when the meocolon was sutured to the anterior wall of the stomach vomited so strenuously after operation that he had to be re-operated upon twice. This patient finally died of pneumonia. Of the 4 deaths due to peritonitis 1 patient had even traction of the small bowel for 9 hours before discovery and repair. This 46 year old patient had a large ventral hernia, following the 2 previous laparotomies which could not be properly repaired at the time of the third operation. The second death from peritonitis was due to infection not however due to failure of the suture line.

The significant difference in the mortality rate following radical operations for gastrojejunal ulcer after gastroenterostomy, 5.1 per cent and after resection, 23.5 per cent, should I believe, determine the indications for the management of a recurrent ulcer. Although I never hesitate to advise operation for a gastrojejunal ulcer following a gastroenterostomy in those cases in which the ulcer recurs after resection, I advise medical treatment first. If repeated courses of treatment fail, despite its danger new surgical interference is indicated.

The radical operation for a recurrent gastrojejunal ulcer is attended with a higher mortality rate not only because it is more difficult to perform, but also because the patient, due to previous operations and prolonged illness,

has often become a morphine addict. Of 14 such patients 3 died, a mortality of 21.4 per cent.

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A 29 year old patient who also had had 3 previous operations 2 gastroenterostomies and 1 resection with a Y anastomosis required surgical relief for a large penetrating ulcer. This patient died from peritonitis that developed not from seepage through the line of suture but from infection that developed as a result of the poor asepsis maintained in that operating room. The third death was due to necrosis of the wall of the stomach for during the resection the left gastric and last branch of the gastroepiploic arteries had to be ligated and the diaphragmatic arteries failed to provide an adequate blood supply.

A gastrocolic fistula complicating a gastrojejunal ulcer has a grave prognosis, for the patient loses weight very rapidly and may die of inanition without surgical interference. However if such a fistula is not opposite the opening of the gastroenterostomy but is distal to it the patient may live for many years because most of the intestinal contents will proceed through its normal course into the small bowel and not through the short circuit into the colon.

Six years ago I operated upon a 50 year old patient on whom the roentgenologist Dr. Fread 14 years previously had demonstrated the existence of a jejuno-colic fistula following a gastroenterostomy. Finally after years of reasonable comfort this patient sought relief for severe pains and repeated hemorrhages. A 2 fingers width jejuno-colic fistula was found in the distal loop of the jejunum 5 centimeters distal to the gastroenterostomy where there was also a gastrojejunal ulcer. Following resection of the colon with side to side anastomosis resection of the anastomotic loop with end to side anastomosis and resection of the duodenum and two-thirds of the stomach with anastomosis according to the Hofmeister Finsterer technique the patient completely recovered.

Gosset reports a similar case. The patient had a jejuno-colic fistula of 5 years standing.

progressive anemia, 2,500,000 red blood cells, hemoglobin 30 per cent, pulse 120, soft, on January 31, 1930. There was a large stump of stomach left after a Billroth II, the small and large intestines were filled with blood, and a callous gastrojejunal ulcer was present at the site of the gastro-enterostomy opening. The stump of the stomach and the jejunal loop were resected. The jejunum was united with an end-to-end anastomosis, and an end-to-side anastomosis was performed with the small stomach stump. The abdomen was then closed. The immediate course was good. The pulse on the second day was 80 and there were no pains. In the evening pains developed in the right lower abdomen with a temperature of 39 degrees centigrade, pulse 128. On the third day the pain was localized over the appendix. Fair results were obtained by enema. Consent to operate was refused by the patient upon advice from the internist. On the fourth day the pains extended anteriorly, temperature rose to 39.5 degrees centigrade, pulse 120, and the patient consented to the operation. A lateral incision evacuated a putrid hemorrhagic exudate from the retroperitoneal space. The appendix, retrocecal and gangrenous, could not be removed without opening the peritoneum. Drainage was resorted to, and bacteriological examination revealed streptococci, which accounted for the serum. In due time a septic diarrhea appeared and persisted for 5 days when the patient died.

In a 27 year old man, operated upon during the war, was found an erosion of the middle colic artery, that had developed on the tenth day of the hemorrhage. Despite severe anemia, pulse 146 palpable only over the carotid, the patient had been given 0.2 grains of morphine in the medical ward. During the operation, which consisted of ligature of the middle colic artery, excision of the anastomotic loop with the ulcer, extraperitonealization of the colon for the 2 stage operation, he repeatedly stopped breathing, because of paralysis of the respiratory center from the severe anemia and the morphine. The pulse remained 146, palpable only over the carotid. At the conclusion of the operation, respiration again stopped for which artificial resuscitation was continued for 1½ hours at which time the heart stopped.

In a third and fourth case of radical operation patients died from peritonitis and pneumonia. It is questionable whether these 2 deaths could have been prevented by doing only a simple operation, namely, excision of the bleeding ulcer. A transfusion might have saved them but due to the circumstances a transfusion was impossible.

The acute perforation of a gastrojejunal ulcer is a rare but serious complication which can be cured only by operating promptly. I have observed only 2 such cases.

One of these was a 78 year old man upon whom 28 years previously a surgeon had performed a gastro-

enterostomy for a duodenal ulcer. Despite the constant diet observed, this man had periodic pain. Suddenly he developed a severe gastric hemorrhage followed by a perforation 12 hours later. Eight hours later, with diffuse peritonitis present, the abdomen was opened under local anesthesia and evipan. Due to its size, closure of the ulcer was impossible. Therefore, the gastro-enterostomy was discontinued, the stomach closed, the ulcer excised from the jejunal loop, and the jejunum reunited with end-to-side anastomosis. The old duodenal ulcer was healed so that normal anatomic relations were restored, and the peritoneal cavity was irrigated with normal salt solution. The immediate response was good with normal peristalsis established. However, on the 5th day the patient developed a cerebral hemorrhage from which he died 24 hours later.

The radical operation for gastrojejunal ulcer, and especially for gastrocolic fistula, is so serious, that one must give the type of anesthesia careful consideration. More than 15 years ago I pointed out in my monograph that the

TABLE IV.—ANESTHESIA IN UNCOMPLICATED CASES

	Number	Mortality	Per cent
General narcosis	19	8	42.1
Localesenteric and splanchnic	177	16	9.0
Total	196	24	12.2

reduction in the mortality rate of major abdominal surgery, performed under local anesthesia, justifies its serious consideration. Today, based upon more than 6,000 laparotomies performed under different types of local anesthesia, I can corroborate that statement. By precluding deep ether anesthesia, one can prevent those deaths that, commonly ascribed to operative shock, are really due to the after-effects of protracted anesthesia upon the parenchymatous organs. Because the normal resistance of peritoneum and lung, otherwise affected by general anesthesia, are not disturbed by local anesthesia, a marked reduction in the number of deaths due to peritonitis and pneumonia can be effected. This is shown so well by the radical operation for gastrojejunal ulcer.

In 19 cases the operation was started under general anesthesia solely, upon the insistent demand of the patient who was really otherwise physically fit. Immediately after induction, the general anesthetic was supported by local infiltration of the abdominal wall and

third because peristalsis failed to establish itself a Witzel fistula was made in the cecum to relieve pressure on the sutures in the colon. Through this the bowel emptied itself but infection developed in the abdominal wall and after a continuous high temperature for 7 weeks the patient expired due to chronic sepsis.

The 2 stage colon resection is indicated in those individuals in whom simple closure of the fistula is impossible due to its size and to surrounding infected areas. With such a procedure one can achieve fine results. The following case history is an example of this procedure.

A 61 year old man was sent to me from Yugoslavia with a gastric history of 14 years. He had had 3 severe hemorrhages, a gastro enterostomy 3 years previously followed by recurrence of periodic pain and since then 5 profuse hemorrhages, severe diarrhea for 3 weeks, and fecal vomiting for 2 weeks accompanied by rapid loss of more than 20 kilograms in weight. An x ray diagnosis showed a gastroduodenal fistula. The patient was emaciated, weighing but 40 kilograms although he was 175 centimeters tall. He was severely anemic, 2,500,000 red blood cells, hemoglobin 40 per cent and pulse 120. The operation was performed September 25, 1936, with splanchnic anesthesia, 20 cubic centimeters of one fourth per cent novocain being used. Many adhesions were found. There was a posterior gastro enterostomy with an entero anastomosis where an ulcer tumor the size of a man's fist had broken through the transverse colon. The duodenal ulcer had healed. The duodenum, two thirds of the stomach with the anastomotic loop and the entero anastomosis were resected. The duodenum was closed, the jejunum united with an end to end anastomosis and distally to this an end to side anastomosis with the remaining part of the stomach was performed. The transverse colon was resected, the distal end being closed and the proximal end sutured into the lower end of the incision as an artificial anus. The postoperative course was smooth. The specimen (Fig. 1) showed a very large opening 5 centimeters in diameter in the transverse colon opposite a very small gastro enterostomy opening. The proximal jejunal loop was dilated and the proximal portion of the transverse colon was stenosed. Convalescence was rapid with recovery of loss of weight. Six weeks later after mobilizing the splenic and hepatic flexures the colon was united with side to side anastomosis. From this the patient recovered quickly regaining all weight loss. On July 20, 1938 this patient was entirely well.

Of 6 patients with a 2 stage colon resection, 2 died.

A 39 year old man died on the fifth postoperative day from peritonitis but the autopsy showed no

leakage through the anastomosis. A 58 year old patient with recurrent gastroduodenal ulcer died on the eleventh postoperative day with broncho-pneumonia due to severe chronic bronchitis. The autopsy revealed no pathological change in the abdomen.

Gastroduodenocolon resection is attended with a high mortality. In 1931, Gosset had collected from the literature reports of 28 cases with 12 deaths a mortality of 42.8 per cent. Since 1931, 1 case each was reported by Hoffmann, McLean, and Verebely, 1 of which recovered. My own records show the same high mortality, 13 cases with 5 deaths. Perhaps the results can be improved with the 2 stage resection of Wilkie in which, at the first stage only, the fistulous tract is completely excluded and the colon reunited. Through this the danger of inanition can be avoided. After the patient has recovered sufficiently, the stomach, loop of the jejunum, and the excluded part of the colon can be resected in the usual manner, so that the danger of peritonitis, due to the separation of the colon and its closure, can be avoided altogether.

Prognosis in acute profuse hemorrhage depends upon the time of the operation. Even in severe cases the results are good, provided that operative treatment can be started within 24 to 48 hours without first attempting medical therapy. All of 5 such patients operated upon were cured. In 1 of these only the bleeding ulcer was excised, and in 4 a radical operation was performed. In 1 of these patients, a 40 year old man, the middle colic artery was eroded in the base of the penetrating ulcer.

With delayed operations that were performed after the third to the tenth day, because the hemorrhages persisted despite medical treatment and repeated transfusions, the results were not good. Of 6 such cases, 4 patients died. However, the death of 1 of the latter was due neither to hemorrhage nor to operation but to sepsis from a gangrenous appendix.

A 44 year old man gave a history of a pyloric and gastric resection 19 years previously after which there was a prompt return of his pains. He had had repeated courses of medical therapy with periods of improvement. Four severe hemorrhages occurred which were accompanied by fainting spells, the last hemorrhage taking place 4 days previous to admission. Hemorrhage recurred despite special medical treatment. The patient was operated upon for a

—AGE OF UNCOMPLICATED CASES

Number	Mortality	Per cent
20	2	10 0
57	3	5 2
72	10	13 8
33	6	18 1
11	2	18 1
3	1	33 3
196	24	12 2

These deaths were the results of the 5 cases: 3 were due to general anesthesia; to the use of the method of Billroth I, 1 to the use of the method of Wermer's modification; 1 was due to the misplaced fixation suture of the mesocolon which was the result of leakage from the end-to-end anastomosis of the jejunum, which occurred because the afferent loop of the end-to-end anastomosis was so short that it pulled directly on the proximally located end-to-end anastomosis; and finally 1 case was due to rupture of the bowel through the abdominal wall which broke down because of an inoperable ventral hernia and vomiting, which could have been avoided by a properly applied abdominal binder. The 4 deaths from peritonitis due to infection from without also could have been avoided had it been possible to perform all the operations in one reliable institution instead of in 9 different hospitals. So, the mortality rate of radical operations performed under local anesthesia could be reduced to 4 per cent without selecting cases, which is, after all, the mortality rate of primary ulcer resection.

Of greatest importance are the permanent results achieved by repeated gastric operations. What procedure should be adopted to prevent a recurrence? Is it possible to cure these patients permanently through repeated operations, or are they to be classified as surgically incurable due to a marked disposition toward developing recurrent ulcers? The answer to these questions could be learned only by subsequent re-examination, or at least from reports submitted by the patient. In those cases, lacking a follow-up report, can be included some who failed to reply, because they were either disappointed with end-results, or had even submitted to further surgery by some one else. Therefore, every statistical report including more than 10 per cent of such



mesentery in order to block the field of operation and so to prevent the operative shock described by Crile in his well known book, *Surgical Shock and Shockless Operations through Anoci-Astociation*, and also to reduce the amount of ether and nitrous oxide required. Ordinarily, with such a procedure only 180 to 300 cubic centimeters of open ether were required. Of these 19 patients 8 died, a mortality of 42.1 per cent.

In 3 instances the cause of death was an infection, peritonitis, and subphrenic abscess. In a fourth re-opening the abdomen revealed an obstruction high in the small bowel due to an adhesion of the bowel with a hematoma that had developed after operation. A 36 year old man who had to have a radical operation for a gastrojejunal ulcer following resection presented many adhesions about the proximal jejunal loops which had to be separated. Three days later when the wound had to be reopened for continuous vomiting only fresh adhesions were found and no peritonitis. The patient expired 3 hours after operation. There was no autopsy.

In 3 cases death could be accounted for by the general anesthetic.

A 58 year old man who insisted upon a general anesthetic and who had 120 cubic centimeters of open ether and 200 cubic centimeters of closed ether died suddenly 1 hour after the conclusion of the operation. Autopsy showed a thrombosis in the right coronary artery. A 47 year old colleague who was given 300 cubic centimeters of open ether in addition to the local anesthetic died 36 hours after operation of cardiac failure despite the fact that normal peristalsis had already re-established itself. A 52 year old man given 300 cubic centimeters of open ether to support local anesthesia for a radical operation showed typical postanesthetic gastroparesis atony that is continuous vomiting, yet normal bowel movements. Intervention on the fourth day showed the stomach stump and proximal jejunal loop 1½ meters to be greatly dilated and parietic with the remaining small bowel showing normal peristalsis without any adhesions.

I have observed this atony 5 times in 700 laparotomies performed under a general anesthetic probably due to a paralysis of an innervation center for the stomach and upper part of the jejunum, and yet have never encountered such atony in over 6,000 operations performed under local anesthesia.

Of 209 operations performed under local anesthesia, 155 required no general anesthetic whatsoever while 54 required slight support with open ether, 30 to 50 cubic centimeters,

and at no time exceeding 150 cubic centimeters during the entire procedure. Of these 29 died, or 14.1 per cent. By subtracting 32 cases complicated with acute profuse hemorrhage, acute perforation, and gastrocolic fistula, the correct mortality rate for radical operation under local anesthesia is only 9 per cent or 177 cases with 16 deaths. None of these died within the first 5 days of so called operative shock, and only 1 died with pneumonia.

A 70 year old man presented the following history. A gastro enterostomy had been performed 30 years prior to admission but his periodic pains returned together with repeated hemorrhages. Two months before frequent vomiting occurred and he had suffered a loss of 30 kilograms in weight. The laparotomy under splanchnic anesthesia using one fourth per cent novocain revealed a duodenal ulcer penetrating into the pancreas, a large gastrojejunal ulcer penetrating into pancreas and mesocolon and about to perforate into the transverse colon. The duodenum was resected without excising the base of the ulcer and the duodenum was closed. The gastroenterostomy loop was separated from the base of the ulcer which measured 5 by 3 by a centimeter. Resection of two thirds of the stomach with the anastomotic loop was performed and an end-to-end anastomosis of the jejunum distally to which an end-to-side anastomosis according to the Hofmeister Finsterer technique was done. The base of the ulcers was drained. There were no postoperative abdominal complications however the patient died 1 week later with bilateral bronchopneumonia which developed because he was too feeble to raise the sputum accumulating from his severe chronic bronchitis.

Three deaths, caused by peritonitis from leakage through the line of sutures, high intestinal obstruction through occlusion of the end to end anastomosis of the jejunum and acute pancreatitis, can be accounted for by the technique employed, either Billroth I or Haberer's modification of it. Two patients died with a subphrenic abscess and a gastric fistula. Of 7 deaths due to peritonitis 3 could have been avoided. One was caused by prolapse of the bowels due to a large inoperable ventral hernia, another was due to perforation of the anterior wall of the stomach induced by the cutting through of a poorly placed fixation suture of the mesocolon slit and another was the consequence of necrosis in the posterior wall of the stomach. Four deaths resulted from peritonitis that developed as a result of

of the posterior gastro-enterostomy with the gastrojejunal ulcer was done and a new gastro-enterostomy created. At the third operation which I performed in November, 1923, at the Buffalo Sisters Hospital, 2 callous gastrojejunal ulcers, an old duodenal ulcer, and a marked dilated stomach were found. A follow-up report from Dr. Burke related that the patient was well until 1931 at which time the periodic pain had returned, and that in 1934 an acute perforation of a recurring gastrojejunal ulcer was closed. No further reports were available on this case.

A 39 year old man had 6 operations performed upon his stomach from 1930 to 1934 including 1 gastro-enterostomy and 2 resections by other surgeons. In February, 1934, a seventh operation was performed by myself for a recurrent gastrojejunal ulcer, i. e., a resection of the large stomach stump with the anastomotic loop, end-to-end anastomosis with the jejunum, and end-to-side anastomosis with the stomach. Because of kinking of the afferent loop an entero-anastomosis had to be added. Nevertheless, after this operation pain soon recurred despite repeated efforts with medical therapy. In April, 1935, I performed the eighth operation and found a large gastrojejunal ulcer penetrating to the mesocolon and transverse colon. My procedure in operating was the following: Resection of the anastomotic loop with entero-anastomosis and with so small a portion of the stomach as was technically necessary, end-to-end anastomosis of the jejunum, distally end-to-side anastomosis according to Hofmeister-Finsterer and cholecystectomy. The patient has remained completely recovered during the past 3½ years.

Two physicians, one 67 and one 68 years old, are dissatisfied with operative results. In the first case, pain was produced by a large ventral hernia of 14 years' duration, there were repeated attacks of chronic obstruction and symptoms of too small a stomach due to its slow emptying, which was a direct result of many adhesions. In the second case, the recurrence of the ulcer can be explained. The accompanying entero-anastomosis failed to neutralize the acid gastric content at the point of the gastro-enterostomy. Despite the fact that practically no further stomach resection was performed, the patient remained permanently cured.

Every entero-anastomosis favors the development of a gastrojejunal ulcer if the bile and duodenal content really pass through the entero-anastomosis. This is not always so, because neutralization of the gastric content at the point of the gastro-enterostomy is impossible. For this reason I include entero-anastomosis only when there is kinking of the afferent jejunal loop.

Roux's Y-shaped anastomosis led to poor permanent results. Of 21 patients only 7 were

cured, 1 improved, while 13 or 61.9 per cent, remained unimproved. In 6 of these 13, the diagnosis of recurrent gastrojejunal ulcer was established upon re-operation, and in 7 the diagnosis was indicated by the recurrence of periodic pains, hemorrhage, and x-ray findings. If the gastric secretions have not become neutral, which does not always follow after resection of half of the stomach, and which almost never follows resection of the antrum, the gastrojejunal ulcer will recur after a Y-shaped anastomosis; because that part of the anastomotic loop between the gastro-enterostomy and the entero-anastomosis is exposed to the acid contents of the stomach which are first neutralized by bile and duodenal secretions at the entero-anastomosis. Only if the gastric secretions are neutral through extensive resection of the stomach, can one achieve a permanent cure with a Y-shaped anastomosis.

This is well illustrated by 2 patients, brothers, 42 and 44 years of age, upon whom I operated 19 years ago for gastrojejunal ulcers that developed after gastro-enterostomy. At this time only half of the dilated stomach with the pylorus and the anastomotic loop were removed, and a Y-anastomosis performed. After 6 weeks, pain, hemorrhage, and heartburn returned. Despite repeated efforts with medical therapy in various institutions there was no improvement. The pain finally became so severe that 6 grains of morphine administered every 24 hours failed to control it. At the third operation performed upon the brothers in 1921, a large recurrent gastrojejunal ulcer was found penetrating into the pancreas and mesentery of the anastomotic loop, and extending down to the junction with the afferent loop. At that time so large a part of the stomach and also of the Y-shaped anastomosis was resected that only about one-fifth of the normal stomach remained. A new Y-shaped anastomosis was performed. These patients recovered quickly, gaining 15 and 20 kilograms in weight, and have remained free from all symptoms for the past 17 years. Moreover, they observe no diet restrictions and are fully able to work.

I no longer employ the Y-shaped anastomosis, which I favored 15 years ago because it was somewhat easier to perform. The results obtained by it are poor. Moreover, 14 years ago I openly criticized this procedure which until recently was still practised by some surgeons. Lahey also criticizes this operation as a result of his unsatisfactory experiences.

TABLE VI — END RESULTS OF RADICAL OPERATIONS PERFORMED 1912-1935

Type of operation	Cured			Improved			Unimproved		
	No	No	Per cent	No	No	Per cent	No	No	Per cent
Billroth I	7	4					3		
Haberer's modification of Billroth I	22	17	77.2	3	13	6	2	9	0
Hofmeister Finsterer's modification of Billroth II	96	83	91.6	4	4	1*	4	4	1
Y shaped anastomosis (Roux)	21	7	33.3	1	4	7	13	61	9

\*The total cured and improved according to the Hofmeister Finsterer technique is 95.7 Per cent

cases is of little value. Because I failed to obtain follow up reports in 6 of the 9 patients operated upon for gastrojejunal ulcer in the States, my statistics for "lost" cases has increased to 64 per cent.

Recurrence of a gastrojejunal ulcer after excision is inevitable due to failure to remove one or more of the causal factors. The separation of a gastro enterostomy with closure of the stomach and the jejunum, thereby effecting restoration of normal anatomical relations, should be the method of choice according to Allen and Judd for the management of a gastrojejunal ulcer. This I do only when no gastrojejunal ulcer is present and moreover no ulcer probably ever was present. When a gastrojejunal ulcer is present the simple degastro enterostomy will lead to recurrent duodenal ulcer. I performed a typical resection upon 5 patients for recurrent duodenal ulcer following a simple degastro enterostomy for gastrojejunal ulcer which had been performed by other surgeons.

To prevent the recurrence of a gastrojejunal ulcer Baum and later Haberer advised the completion of the radical operation with a Billroth I. It is true that this will positively prevent the return of a gastrojejunal ulcer, but not the recurrence of a duodenal ulcer, because the resection simply cannot be as extensive as with the Billroth II or its modifications. Otherwise the tension on the suture lines leads to leakage, peritonitis, and death. According to the experimental work of Smidt, the removal of half of the stomach in the Billroth I may be sufficient because the entrance of the gastric content into the duodenum provokes a prompt reflex stimulus from Brunner's glands, which inhibits the production of

hydrochloric acid in the fundus. This reflex cannot start with a Billroth II except that there may be a retrograde filling of the duodenum.

With the Billroth I, my experiences have been unsatisfactory. In my work with 8 cases 1 patient failed to reply, 4 were cured, and 3 developed a recurrence of the duodenal ulcer as demonstrated at postmortem in 1 and reoperation in 2 cases. These latter were cured by a new extensive resection with anastomosis according to the Hofmeister Finsterer technique. Horsley also reports 2 recurrences of duodenal ulcer after a Billroth I.

The end to side gastroduodenostomy, according to Haberer, leads to better permanent results, because the acid gastric content enters the duodenum opposite the papilla and is immediately neutralized. Of 24 cases, 7 patients failed to report and 17 are fully cured 77.2 per cent, 3 patients were improved, 2 of whom had developed pulmonary tuberculosis and 1 cholecystitis, and 2 were unimproved, 9 per cent.

A 38 year old man was symptom free for 6 years following a radical operation in 1928. Since 1934 he has had periodic pains and once a black tarry stool. A 37 year old man was symptom free for 2 years after which he developed periodic pains, heartburn and repeated small hemorrhages and in May 1935 he had a severe hemorrhage. X ray examination then showed a callous gastric ulcer.

The best permanent results could be attained through the extensive resection of the stomach in which at least two-thirds to three-fourths of the stomach are removed, and an end to side anastomosis performed according to the Hofmeister Finsterer technique. Of 96 patients 83 are permanently cured, or 91.6 per cent. These have no dietetic restrictions, have gained up to 30 kilograms in weight, and are fully able to work. Forty one cases were operated upon 10 to 20 years ago, so that one can really consider them permanently cured. Four patients are improved for they have no pain, they do have occasional periods of anemia and 1 patient also has pulmonary tuberculosis. Four patients remain unimproved, or 4.1 per cent.

A 28 year old man in 1920 had a gastro enterostomy for a perforated duodenal ulcer. In 1922 an excision

to re-operate, he found 12 patients with hyperacidity, 12 patients with normal acidity, and 2 patients with hypoacidity, but not 1 patient with anacidity

It is true that extensive resection has some disadvantages especially the complaints referable to a small stomach. In my experience this is present only in the early months, disappearing in more than 90 per cent of such patients with the gradual dilatation of the anastomotic loop. Nor is there much likelihood that either secondary or pernicious anemia will develop, although I have observed 2 of the latter. With modern liver therapy these can be controlled easily. When comparing the minor complaints with the dangers of a gastrojejunal ulcer, one cannot consider the former justifiable contra-indications against extensive resection. And until a more effective nonoperative treatment is found, extensive primary gastric resection is justified to avoid a gastrojejunal ulcer as much as possible.

#### CONCLUSIONS

A report of 331 repeated gastric operations with a mortality of 11.7 per cent is given. After those cases complicated by acute perforation, acute hemorrhage or gastrocolic fistula are subtracted, the mortality drops to 8.6 per cent.

The most frequently performed previous operation was gastro-enterostomy, 190 cases, after which either the old ulcer had not healed, or a gastrojejunal ulcer had formed. Therefore, I consider gastro-enterostomy an operation to be performed only in rare, exceptional instances.

The radical operation for a gastrojejunal ulcer, following posterior gastro-enterostomy, shows a lower mortality, 6.8 per cent, than when it follows resection, 23.5 per cent. Therefore, an operation is indicated at once by the return of complaints in a patient after gastro-enterostomy, and it is to be delayed, if the complaints return after resection until at least several attempts with medical therapy have been made. The mortality rate attending the radical operation for recurrent gastrojejunal ulcer is 21.4 per cent.

The radical operation for a gastrocolic fistula has a higher mortality rate even if the

colon is only separated and closed. The danger lies in the unreliability of the colon sutures, due to the surrounding inflamed area, 6 cases with 2 deaths. The high mortality of 5 deaths out of 13 cases for resection of the stomach and colon can be reduced by performing a 2 stage resection of the colon.

In a case of acute profuse hemorrhage from a gastrojejunal ulcer, the radical operation performed immediately is attended with good results. I had 5 such patients and all were cured. If performed late after unsuccessful medical treatment, it is attended with poor results, for of 6 such patients, 4 died. Therefore, early surgical intervention should be instituted promptly.

In acute perforation even the lesser operation, either closure or excision of the ulcer, produces poor results.

The mortality rate attending the radical operation for gastrojejunal ulcer depends also upon the type of anesthetic employed. The radical operation under general anesthetic, ether or nitrous oxide, was performed rarely and only in uncomplicated cases, when the patients were young and strong and insisted upon it. Radical operation for gastrojejunal ulcer showed a mortality rate of 42.1 per cent, or 19 cases with 8 deaths. Of these, 3 deaths were directly attributable to the anesthetic. With local anesthesia, splanchnic anesthesia, the mortality rate was 14.1 per cent, or 209 cases with 29 deaths, and by subtracting the 32 cases complicated by acute hemorrhage, perforation, or gastrocolic fistula, the correct mortality rate is 9 per cent. There was not a single death after operation due to so called operative shock and only 1 death due to pneumonia, despite the fact that 14 patients ranged from 60 to 78 years of age.

The best permanent results are achieved with the extensive two-thirds to three-fourths resection of the stomach and the preparation of the end-to-side anastomosis according to Hofmeister-Finsterer, even though there may have been several preceding operations. Of 96 cases 88 are permanently cured, or 91.6 per cent.

With the Billroth I the end-results are not as good, 4 cases cured, 3 cases unimproved. With terminolateral gastroduodenostomy of

Those patients, in whom gastrojejunal ulcer recurs after repeated operations upon the stomach are often considered "surgically incurable." I have again and again asserted that those patients, classified by Mandl as "surgically incurable" after repeated operations upon the stomach, have never really had a gastric resection. Upon a patient so classified by Mandl a fourth operation, which was a typical resection of two thirds of the stomach, actually resulted in a permanent cure. The cause of repeated recurrent ulcers is not an unusual disposition to develop ulcers which cannot be controlled surgically, but is the failure to do a sufficiently extensive resection of the stomach as for example, resection of only the antrum, or a Y shaped anastomosis, or an entero anastomosis. This can be illustrated by the following case:

A 33 year old man had had 4 operations upon the stomach by 4 different surgeons (1) a posterior gastro enterostomy (2) closure of the posterior gastro enterostomy and the formation of an anterior gastro-enterostomy with an entero anastomosis (3) resection of the pylorus and antrum with the anastomotic loop and an end to side anastomosis, and (4) a Y shaped anastomosis because of a recurrence of the gastrojejunal ulcer with stenosis following which a gastrocolic fistula developed with a marked loss of 40 pounds in weight. At the fifth operation performed under splanchnic anesthesia with one fourth per cent novocain solution it was found that the former ulcer at the end to side anastomosis had healed and a new ulcer had formed at the Y shaped anastomosis which had perforated into the colon. In operating the following procedure was followed. Resection of the transverse colon resection of the large stump of the stomach lesser curvature 10 centimeters and greater curvature 15 centimeters with both anastomosis and the old entero anastomosis a side to side anastomosis of the transverse colon an end to end anastomosis of the jejunum and distally to this an end to side anastomosis with the stomach according to Hofmeister Finster. Recovery without complaints followed with a marked gain in weight of 20 kilograms. However 4 years later this patient died with tuberculosis of the larynx and lung. The autopsy revealed no pathological lesion in the stomach.

My statistics show 8 instances wherein the patient had been operated upon 3 to 6 times without permanent success. Nevertheless, even these cases could be permanently cured by another more extensive gastric resection.

Balfour had 3 similar cases of repeated recurrent ulcer following resections, in whom the

last operation of terminolateral gastroduodenostomy was attended with a permanent cure.

For the patient it is surely better to prevent a gastrojejunal ulcer with its high attendant mortality. This can be achieved if the gastroenterostomy is employed only in rare exceptional cases, and if, with the resection of the ulcer, or with my method of resection for exclusion of a non removal duodenal ulcer, a very large part of the stomach is removed so that permanent gastric anacidity is established. The removal of the antrum, i.e. the distal third of the stomach, which is still called an extensive gastric resection by many surgeons is no guarantee of permanent cure. At least two thirds of the stomach, and in cases with a marked dilatation of the stomach in which only the antrum is dilated three fourths and more of the stomach must be removed so that finally there remains only the normal cardiac third of the stomach. The resection can be considered adequate only when it continues to the point on the lesser curvature where the left gastric artery from the celiac axis comes to the stomach, and on the greater curvature to a point which is a hand's breadth to the left of its midpoint, recognizable by the absence of the arcade. Since 1918 I have recommended the two thirds resection as a routine method, but in 1920 Haberer and Schmieden disagreed because they believed that this operation was too radical and that resection of the antrum was sufficient. In 1922, Hohlbaum called this procedure vandalism in the field of surgery. But experience has shown that my proposition, namely, that the most reliable permanent cure could be effected only by the extensive two thirds resection of the stomach was correct. With resection of the antrum, which I occasionally performed years ago there was recurrence in 4 out of 28 patients so operated upon, 2 gastrojejunal ulcers, and 2 recurrent duodenal ulcers, while with the two thirds gastric resection employed in the last 15 years with over 1,500 cases only 1 patient had to be re-operated upon for gastrojejunal ulcer. Recurrence follows upon failure to establish anacidity by sufficient extensive resection. In 28 patients with gastrojejunal ulcer after resection upon whom I nedemann had

# RECURRENT HYPERTHYROIDISM

A Report of 306 Cases Operated upon from 1928 to 1937

RICHARD B. CATTELL, M D, F.A.C.S., and EDWARD S. MORGAN, M D.,  
Boston, Massachusetts

**R**ECURRENCE or persistence of the symptoms of hyperthyroidism following surgical treatment is sufficiently frequent to demand our attention. Subtotal thyroidectomy is recognized as the most effective means of relieving the symptoms of hyperthyroidism as 90 to 95 per cent of patients obtain satisfactory results. In the small group of unrelieved patients the largest number of unsatisfactory results are due to the recurrence of symptoms. In spite of the large number of reports in the literature dealing with the surgical treatment of hyperthyroidism, there have been relatively few which have concerned themselves primarily with the problem of recurrent and persistent hyperthyroidism. Lahey and Clute (11), Thompson, Morris and Thompson, Jackson, Pemberton, Else, Crile, and more recently Gillette and Scott have presented the incidence, means of prevention, and treatment. In a previous report from this clinic, Lahey and Clute (11) reported 48 cases up to 1926. It is the purpose of this study to present the factors responsible for the persistence or recurrence of symptoms following operation, outlining the management of these cases at the Lahey Clinic during a 10 year period from 1928 to 1937 inclusive. During this time 306 patients were operated upon for this condition and an additional small group were treated medically.

## DIAGNOSIS

The diagnosis of recurrent and persistent hyperthyroidism presents the identical problem as does the disease in its original form, and for this reason it is unnecessary to discuss this aspect in detail. With their previous experience these patients are likely to recognize the fact that they have had a recurrence

of their trouble. In the milder cases, nervousness, persistent tachycardia, and palpitation are common complaints. Weight loss in spite of adequate food intake and inability to carry out a normal activity, without exaggeration of symptoms, make one suspicious of a return of the hyperthyroidism. A return of the eye signs, particularly stare and exophthalmos, is present. It is important to realize that palpitation of the thyroid remnants is unreliable. The scar tissue resulting from the previous subtotal thyroidectomy makes it difficult to outline the lateral thyroid lobes. For this reason particular emphasis should be placed on the patient's story rather than on the examination of the gland. The diagnosis will usually be established by determining the basal metabolic rate.

## PERSISTENT AND RECURRENT HYPERTHYROIDISM

Patients presenting symptoms of hyperthyroidism following thyroidectomy should properly be divided into the two groups of persistent and recurrent hyperthyroidism. We consider that patients have persistent hyperthyroidism who have not been fully relieved of their symptoms following operation and who do not have a return of the basal metabolism to normal within a 6 month period. If the patient has been relieved of symptoms for an interval of 6 months or more and then has a return, he is considered to have recurrent hyperthyroidism. The division of the cases into these two groups seems important since they present different problems.

Persistent hyperthyroidism is due to the failure to remove sufficient thyroid gland at the original operation. This should properly imply an inadequate procedure and may be due to a number of factors. Dr. Lahey (13) has repeatedly emphasized the necessity of obtaining adequate exposure of the gland

From the Department of Surgery, The Lahey Clinic  
Presented before the Clinical Congress of the American College  
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Haberer 17 cases were cured, 77.2 per cent, 3 improved, 2 unimproved, 9 per cent. In both of these methods a less extensive gastric resection was performed.

With Roux's Y shaped anastomosis permanent results are the poorest, 7 cases cured, 1 case improved, 13 cases unimproved, or 61.9 per cent. There also the two thirds resection of the stomach was inadequate, for a permanent cure is possible only if the gastric juices remain absolutely anacid.

The recurrence of a gastrojejunal ulcer after radical operation is not due to special ulcer disposition but to technical faults, too limited resection, Y shaped anastomosis, or entero-anastomosis. Therefore, by avoiding these errors in technique, permanent cure is possible even after repeated resections. The term, "surgically incurable ulcer," is not applicable to this type of case.

The number of gastrojejunal ulcers can be diminished if the gastro enterostomy is employed in only rare and exceptional cases, and if with the resection of the ulcer and with the resection for exclusion of unremovable duodenal ulcer, not just the antrum, the distal third of the stomach, but at least two thirds of the stomach and in those instances with marked dilatation even three fourths are removed, so that only the normal cardiac third remains. The disadvantages of extensive gas-

tric resection, too small a stomach and anemia, are of little consequence, since they are more easily controlled than a gastrojejunal ulcer following inadequate gastric resection.

We especially wish to express our appreciation to Dr. Burwig, Buffalo, New York, for his translation of this paper from German into English.

## BIBLIOGRAPHY

- 1 ALESSANDRI Zentralbl f Chir 1937 p 1304
- 2 ALLEN Am J Surg 1928 5 128
- 3 BALFOUR Ann Surg 1931 94 489
- 4 BACON Zentralbl f Chir 1921 p 586
- 5 CRILE and LOWER Surgical Shock and the Shock's Operation through Anoci Association Philadelphia W. B. Saunders Co 1921
- 6 FUSTERER Zentralbl f Chir 1918 p 434 Arch f Chir 1924 155 581 1937 189 397 Local Anesthesia Methods and Results in Abdominal Surgery New York Rebman Co 1935
- 7 FREUD Berl klin Wochenschr 1918 p 1021
- 8 FRIEDMANN Zentralbl f Chir 1937 p 271
- 9 GOS ET Congrès franc de chir, 1931 p 31
- 10 HABERER Arch f klin Chir 1922 227 50
- 11 HOFFMANN Zentralbl f Chir 1932 p 917
- 12 HORSLEY Ann Surg 1931 94 490
- 13 JUDD and HERNER Ann Surg 1925 122 1003
- 14 LATT Brit M J 1929 2 1974
- 15 MANOL Deutsche Ztschr f Chir 1920 136 167
- 16 McLEAN Beitr z klin Chir 1932 155 325
- 17 OGILVIE Lancet Lond 1935 p 419
- 18 SMITH Arch f klin Chir 1923 122 26 1924 130 307
- 19 V. VREDELICH Arch f klin Chir 1936 187 468
- 20 WALTON Brit J Surg 1934 22 33
- 21 WILKE Ann Surg 1934 99 401
- 22 ZUCKERNEWERT and FICK Deutsche Zt Chir f Chir 1935 236 424

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of their trouble. In the milder cases, nervousness, persistent tachycardia, and palpitation are common complaints. Weight loss in spite of adequate food intake and inability to carry out a normal activity, without exaggeration of symptoms, make one suspicious of a return of the hyperthyroidism. A return of the eye signs, particularly stare and exophthalmos, is present. It is important to realize that palpitation of the thyroid remnants is unreliable. The scar tissue resulting from the previous subtotal thyroidectomy makes it difficult to outline the lateral thyroid lobes. For this reason particular emphasis should be placed on the patient's story rather than on the examination of the gland. The diagnosis will usually be established by determining the basal metabolic rate.

## PERSISTENT AND RECURRENT HYPERTHYROIDISM

Patients presenting symptoms of hyperthyroidism following thyroidectomy should properly be divided into the two groups of persistent and recurrent hyperthyroidism. We consider that patients have persistent hyperthyroidism who have not been fully relieved of their symptoms following operation and who do not have a return of the basal metabolism to normal within a 6 month period. If the patient has been relieved of symptoms for an interval of 6 months or more and then has a return, he is considered to have recurrent hyperthyroidism. The division of the cases into these two groups seems important since they present different problems.

Persistent hyperthyroidism is due to the failure to remove sufficient thyroid gland at the original operation. This should properly imply an inadequate procedure and may be due to a number of factors. Dr. Lahey (13) has repeatedly emphasized the necessity of obtaining adequate exposure of the gland

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and states that it is impossible to estimate the amount of thyroid tissue removed unless exposure is obtained. Failure to remove all of the superior pole or retrolaryngeal extension is a frequent cause. Failure to remove a pyramidal lobe may likewise result in a persistence of symptoms. A technique which leaves a portion of the isthmus over the trachea does not permit accurate appraisal of the amount of thyroid tissue left *in situ*. Too much thyroid tissue may be left in the usual lateral remnants because of the fear of injury to the recurrent nerve or parathyroid glands. In more recent years when adequate subtotal thyroidectomy has been carried out, persistent hyperthyroidism has been much less frequent. With present day methods we can be less concerned with this condition.

Recurrent hyperthyroidism may occur in spite of apparently adequate subtotal thyroidectomy and may appear at any time following operation. The cause of recurrence is unknown and must be due to the same factors responsible for the original disease. Pemberton called attention to the fact that all recurrences cannot be related to the amount of tissue removed. Thompson et al., Jackson Gillette, Lahey and Clute (11) have all stated that fewer recurrences would occur if sufficient thyroid tissue was removed at the first operation. Because of the frequency of recurrent hyperthyroidism its prevention should be attempted. The most important point emphasized by all authors is adequate subtotal thyroidectomy.

Jackson and Else reported that postoperative administration of iodine will prevent many cases. For a number of years we gave our patients 10 minims of Lugol's solution daily for 3 months following operation. In a later series and at the present time the administration of iodine is discontinued at the time of the patient's discharge from the hospital. A comparison of the recurrent rates in these two groups showed that the administration of iodine did not lower the incidence of recurrence in our cases (7). Brenizer stated that recurrences could not be prevented by iodine. The careful regulation of the lives of patients following subtotal thyroidectomy for a period of months or even a year does, we

believe, lessen the number of patients having later symptoms. This regimen should require adequate periods of rest during this convalescent period, relief of mental and physical stress, absence from work for 6 weeks to 3 months, and the avoidance of stimulants such as alcohol, tobacco, coffee, and tea.

Although a number of authors have stated that the means mentioned have reduced recurrences, it has been impossible to ascertain which patients are likely to have a recurrence of their hyperthyroidism. Cattell and Perkin (3) have recently called attention to the use of the pre-operative blood iodine level as a means of determining the cases that may recur. In a study of a group of 256 patients with exophthalmic goiter they found that all of the recurrent cases occurred in those patients having a pre-operative normal or low blood iodine. In the group of patients observed approximately one fourth had a normal or low blood iodine, yet all cases had an elevated basal metabolic rate. Furthermore, Perkin and Lahey (15) showed that this occurred most frequently in patients who had had the disease for over 1 year. Cattell and Perkin (3) concluded that a more radical subtotal thyroidectomy should be done in a patient having a normal or low pre-operative blood iodine level. This has been the only means so far presented that may aid in the prediction of cases that may have a recurrence of symptoms. In our experience, recurrence of symptoms rarely follows subtotal thyroidectomy for nodular goiter with hyperthyroidism (adenomatous goiter with secondary hyperthyroidism). Patients with a discrete adenoma with associated hyperthyroidism may be relieved by removal of the adenoma unless the remainder of the gland is hyperplastic. We (4) have previously recommended that all of these patients be submitted to subtotal thyroidectomy in order to avoid recurrence since it is not always possible at the time of operation to determine whether hyperplasia is present in the remainder of the gland.

#### INCIDENCE OF RECURRENCE OR PERSISTENCE

During the 10 year period 1928 to 1937 inclusive, 4,956 patients with hyperthyroid

ism were operated upon at the Lahey Clinic. During this time, 306 patients were operated upon for recurrence or persistence of hyperthyroidism (Table I). It is difficult to determine a true incidence of recurrence or persistence unless all cases are carefully followed for a number of years after operation by clinical observation and by basal metabolism determinations. In a group of 190 cases reported by Thompson, Morris and Thompson from the Massachusetts General Hospital, 19.5 per cent had recurrence of symptoms. Jackson, in presenting 22 cases of persistent and 36 cases of recurrent hyperthyroidism, did not state the recurrence rate. Joyce found a recurrence rate of 5.7 per cent in his cases with hyperplastic goiter. Coller and Potter

recurrence of symptoms may occur at any time after operation up to 10 years or more, all figures for recurrence are probably inaccurate.

There were 265 females in our series, or 86 per cent, and 41 males or 14 per cent, giving a ratio of approximately 6 to 1. The average age for both sexes was 39.5 years. In our experience, recurrent hyperthyroidism is rare in children.

#### TREATMENT

Three methods of treatment are available for patients with recurrent hyperthyroidism: radiation, medical, and surgical. Many of the patients with the mild recurrence of symptoms can be satisfactorily controlled with Lugol's solution. They should be carefully followed to make certain that their weight is maintained and that they are able to carry on a reasonable activity. Either medical or roentgen therapy can be used in the mild cases when the thyroid remnants are small. Operation is advised for all patients with persistent hyperthyroidism who are not relieved by medical measures. It has been our policy to do a subtotal excision of thyroid remnants in all cases in which the remnants are demonstrated to be enlarged, when weight is not maintained, when the basal metabolic rate is elevated, and when incapacity is present. The pre-operative preparation is the same as for other patients with hyperthyroidism.

It must be admitted that the secondary operations on the thyroid gland are frequently difficult and unless unusual care is exercised, postoperative complications may occur (Table II). A wide and adequate exposure of the entire gland is even more necessary than in a primary operation if injury is to be avoided to the internal jugular vein, parathyroid glands, and recurrent nerve. The prethyroid muscles should be divided, although it may be impossible to remove the sternothyroid muscle from the gland remnant. The internal jugular vein is then identified, dissected free, and retracted in order to obtain a wide lateral exposure. It is our practice routinely to expose and identify the recurrent nerve and make a careful search for the inferior parathyroid gland. The pyramidal lobe is removed if

TABLE I—INCIDENCE OF PERSISTENT AND RECURRENT HYPERTHYROIDISM IN 4,956\* CASES OF EXOPHTHALMIC GOITER FROM 1928 TO 1937

	No	Per cent
Persistent hyperthyroidism	119	2.4
Recurrent hyperthyroidism	187	3.7
Total	306	

\*165 patients had been operated upon previously at the Lahey Clinic.

reported 267 cases of exophthalmic goiter with a recurrence rate of 4.8 per cent. In our group of 306 patients, 187 were operated upon for recurrent hyperthyroidism and 119 for persistent hyperthyroidism. Of this number, 165 or 53 per cent, had their initial operation at this clinic. Of the total number of cases in which the original operation was done at the clinic, 1.76 per cent of patients showed further symptoms and were operated upon for this condition during the same 10 year period, yet this does not represent the true incidence of the condition. Perkin (16) studied 750 consecutive cases of exophthalmic goiter at the Lahey Clinic, followed for 2 years after operation, and demonstrated a recurrence rate of 5.2 per cent. The average duration of time between the initial and second operation for our cases of recurrent hyperthyroidism was 7 years and 11 months, while in the group of persistent hyperthyroidism, operation was delayed for 2 years and 4 months. Since it has been demonstrated that

present, as well as all thyroid tissue over the trachea. Small portions of thyroid tissue are left along each side of the trachea, preserving as much of the thyroid capsule as possible. In this way the parathyroids will be preserved even though they cannot be identified. A more radical removal of thyroid tissue is carried out in all recurrent cases, as compared to the removal in primary operations.

#### POSTOPERATIVE COMPLICATIONS

The operative mortality in the 306 patients operated upon for recurrent and persistent hyperthyroidism was 1.9 per cent (Table II). This should be compared with our total mortality in all patients operated upon for exophthalmic goiter of 0.67 per cent. Postoperative parathyroid tetany occurred in 2.9

TABLE II.—INCIDENCE OF POSTOPERATIVE COMPLICATIONS FOLLOWING SUBTOTAL THYROIDECTOMY

	Primary operation (1030 cases) per cent	Second operation (306 cases) per cent
Recurrence	3.3	9.2
Hypothyroidism	4.0	6.3
Parathyroid tetany	0.19	2.9
Recurrent laryngeal nerve injury	0	14.7
Wound hemorrhage	0.5	2.6
Tracheotomy	0.5	2.6
Wound infections	1.0	1.6
Operative mortality	0.67	1.9

per cent of the series, as compared with 0.2 per cent in patients not having previous thyroid operation. This high incidence of parathyroid tetany is due to the difficulty of identification of the parathyroid glands during the secondary operation. As stated earlier in this paper we estimate the incidence of recurrent hyperthyroidism in our cases to be 3.3 per cent. After subtotal excision of thyroid remnants, 9.2 per cent of our patients still presented symptoms of hyperthyroidism. This strongly suggests some extrathyroid phase of the disease. The most common postoperative complication was recurrent laryngeal nerve injury. Either temporary or permanent injury to one nerve was noted in 14.7 per cent. This high incidence of recurrent nerve injury has been one of the factors responsible for Dr. Lahey's (12) recom-

mendation that the recurrent nerve be visualized routinely in thyroid operations. If this be done, we know that this figure will be greatly lowered. Six and two tenths per cent of our patients showed postoperative hypothyroidism. This figure is not greatly in excess of the 4 per cent incidence in primary cases. Postoperative hemorrhage and wound infection occurred in a somewhat higher proportion than in primary operations. We wish to emphasize particularly the high occurrence of postoperative complications following subtotal excision of the thyroid remnants for it further emphasizes the seriousness of recurrent hyperthyroidism.

#### SUMMARY AND CONCLUSIONS

Persistent hyperthyroidism follows inadequate subtotal thyroidectomy, and should be treated by subtotal excision of thyroid remnants.

A series of 306 patients operated upon for persistent or recurrent hyperthyroidism during a 10 year period is presented.

Radical subtotal thyroidectomy is recommended for all patients having a preoperative normal or low blood iodine.

Subtotal excision of thyroid remnants is a difficult operation and may be followed by a high incidence of postoperative complications. Means of reducing complications are discussed.

Patients having recurrent hyperthyroidism resulting in inability to maintain weight, with an increased metabolic rate, and inability to work, should be treated surgically.

#### BIBLIOGRAPHY

1. BREYER, A. G. Amount of gland to be left at thyroidectomy. *Ann. Surg.* 1933, 97, 831-843.
2. CATTELL, P. B. The iodine treatment of exophthalmic goiter. *Tr. Second Internat. Goiter Conf.* Bern, Switzerland, 1933.
3. CATTELL, P. B. and PIERCE, H. J. Recurrent hyperthyroidism. Blood iodine values in determining recurrence. *Surg., Gynec. & Obst.* In press.
4. CATTELL, P. B. and LOCKERSON, E. B. Single discrete adenoma of the thyroid with associated secondary hyperthyroidism. *Surg. Clin. N. America* 1935, 10, 1637-1639.
5. COLLIER, J. A. and JOSTER, E. B. The end results of thyroidectomy. *Ann. Surg.* 1931, 94, 568-581.
6. CRILE, G. W. Recurrent hyperthyroidism, neurocirculatory asthenia and peptic ulcer: treatment by operations on suprarenal sympathetic splanchnic nerves. *Am. M. Ass.* 1931, 97, 1616-1618.

7. ELSE, J. E. Prevention of recurrent goiter Surg. Clin N. America, 1928, 8 1375-1394
8. GILLETTE, N W. Recurrent hyperthyroidism West J Surg, 1937, 45 504-510
9. JACKSON, A S. The prevention of persistent and recurrent hyperthyroidism based on a study of 769 cases of exophthalmic goiter Surg, Gynec & Obst, 1934, 58 590-594
10. JOYCE, T. M. Thyroid surgery at the Portland Clinic Tr Am Surg Ass, 1931, 49 149-153
11. LAHEY, F H, and CLUTE, H M. Persistent and recurrent hyperthyroidism Ann Surg, 1926, 83 199-205
12. LAHEY, F H. Routine dissection and demonstration of the recurrent laryngeal nerve in subtotal thyroidectomy Surg, Gynec & Obst, 1938, 66 774-777
13. Idem. How much thyroid tissue should be removed in toxic goiter? Ann Surg, 1932, 95 529-536
14. PEMBERTON, J DEJ. Recurring exophthalmic goiter its relation to the amount of tissue preserved in operation on the thyroid gland J Am M Ass, 1930, 94 1483-1489
15. PERKIN, H J, and LAHEY, F H. Exophthalmic goiter, relation between blood iodine level and duration of symptoms in 305 cases Arch Int Med, 1938, 61 875-879
16. PERKIN, H J. Personal communication
17. SCOTT, A C, JR. Surgery of recurrent exophthalmic goiter Texas State J M, 1937, 32 649-652
18. THOMPSON, W O, MORRIS, A E, and THOMPSON, P K. Thyrotoxicosis following subtotal thyroidectomy for exophthalmic goiter Arch Int Med, 1930, 46 946-978

# CONTRACTURES DUE TO BURNS

W T COUGHLIN, M D, F A C S, St Louis Missouri

A CONTRACTURE is an abnormal shortening of the soft tissues whereby skeletal structures, and often the adjacent soft parts as well, are drawn into and fixed in abnormal position, so that the form is disfigured and the function interfered with. It has long been known that scar tissue contracts as it gets older, and all have noticed that those wounds which healed the most rapidly left the least scar.

Burns take longer to heal than wounds due to mechanical trauma, and almost all those of the third degree suppurate. The pyogenic process is an additional source of irritation to the already injured tissues and a greater production of new connective tissue occurs. Also, these injured tissues require a longer time to heal because not only have surface cells been immediately destroyed, but those directly below have been so seriously injured that they soon die, while those remaining viable are injured in decreasing degree of severity from the surface to the depths where normal tissues remain. Such injured cells cannot respond to the injury until they recover their vitality.

But it is not alone the amount of connective tissue that is the cause of the contracture, for a part, if allowed to heal in the position of greatest ease, may be the site of a disabling contracture, even though scar tissue is present in a very small amount. Joints assume the position of greatest ease by reflex rather than by voluntary action. The underlying muscle contracts to relieve the tension on the burned surface area. If, while in this position, the muscle or the tendon becomes fixed in its sheath—and a very slight amount of exudate in either may be sufficient to cause it to do so—the contracture is continued by the connective tissue, though not primarily caused thereby.

The prevention of the contracture would be better than its cure, but prevention may

From the Department of Surgery, St. Louis University School of Medicine.  
Presented before the Clinical Congress of the American College of Surgeons, New York, October 17-22, 1933.

not be possible. Theoretically, since the contractures follow burns chiefly on the flexor aspects of joints, all that is needed to prevent contracture is the continued immobilization of the part in hyperextension during healing and in complete flexion for a burn on the extensor surface. In treating burns of adjacent sides of fingers or toes, the fingers would be held widely separated, and for the burn in the axilla it would only be necessary to hold the arm in complete elevation, or at least in complete abduction during healing.

No matter what the treatment may be in theory, in practice one is obliged to have regard for the comfort of the patient and the feelings of his friends. Even though one may begin the treatment of an extensive burn with a full understanding of the need for such safeguards and with a zeal for carrying them into execution, his best efforts are often the cause of increased discomfort and complaint, his ingenuity and his patience are taxed beyond capacity, and, finally, his convictions yielding to his compassion, the doctor takes the easiest way and the part heals in the position of greatest ease.

The immediate treatment of the burn will do a great deal toward shortening the time in the hospital lessening the suffering and diminishing the late contractures. Just as soon as shock is past the patient or the part should be anesthetized—and never with a drug which irritates the kidneys—and the burn should be cleaned and sterilized like any other wound, all dead tissue cut away, and the surface

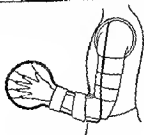


Fig 1 A splint that keeps fingers apart

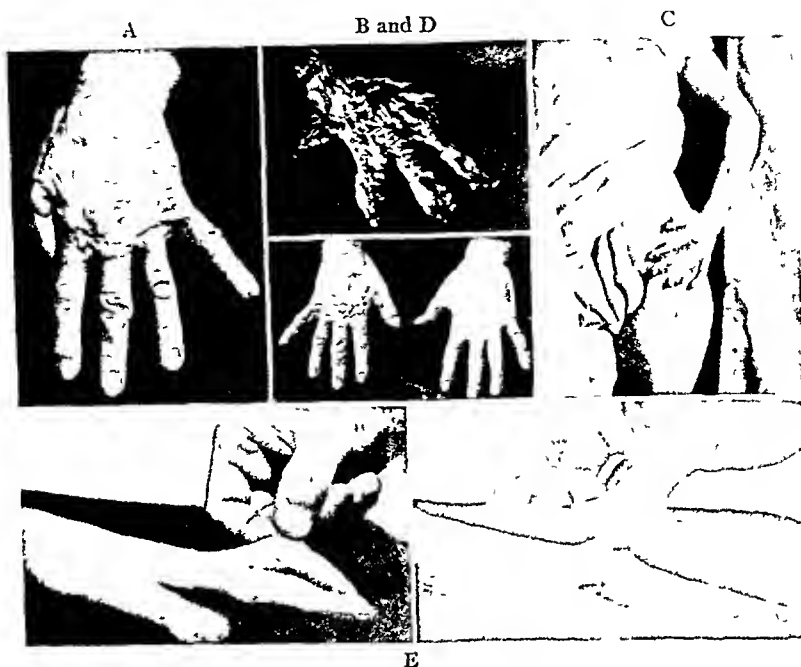


Fig 2 A, The hand has been burned and is unsightly. The first 2 fingers and thumb are webbed. B, The amount of scar removed. C, The hand is in a pocket to cover part of the back of the hand, a separate compartment for each finger. D, Final result. E, The skin is freely movable and can be pinched up like normal skin.

sprayed with 5 per cent aqueous solution of tannic acid at least twice an hour until the crust (coagulum) forms. Thereafter the injured part or the patient is kept naked under the warm tent and made comfortable. After about 3 weeks, or whenever the crust is loosening at the edges, the crust is to be removed and warm hot boric packs applied for a few days when skin grafting should be begun.

Early skin grafting is conducive to a more rapid healing and anything which does this will lessen the contracture. Of all types, the simplest to do is the Reverdin procedure and it can be begun almost as soon as granulations are first seen. It possesses this great advantage that no regular operation is needed. A few grafts may be set at each dressing and by sticking the graft in an oblique slit in the raw surface (the method, I think, of John Staige Davis) one's efforts give excellent results. The Thiersch and the Wolf grafts never have much chance as long as there is pus present, and they require an operation but serve well on sterile wounds.

About the best apparatus for the burned hand is some form of the banjo splint. I do not remember who first devised it and the method of using the finger nails to aid in the holding of the fingers in an extended position, but certainly it is most satisfactory (Fig 1).

When the wrist is burned all the way round, a similar device is used, but this is part of a wire frame splint which fits forearm and arm. Whatever apparatus is used it is much better if it does not touch the burned area and, of course, it must not press on any part of it. Any apparatus will somewhat interfere with the dressings, but one should manage to change the dressings without removing the apparatus. The changing of dressings now is never the ordeal it once was. The open treatment has almost entirely abolished them during the early period, and cellophane, rubber strips, and the olive and cod liver oils have robbed the terror from those dressings necessary later.

The contractures about the hand are like those elsewhere, either of flexor or extensor

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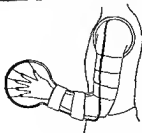


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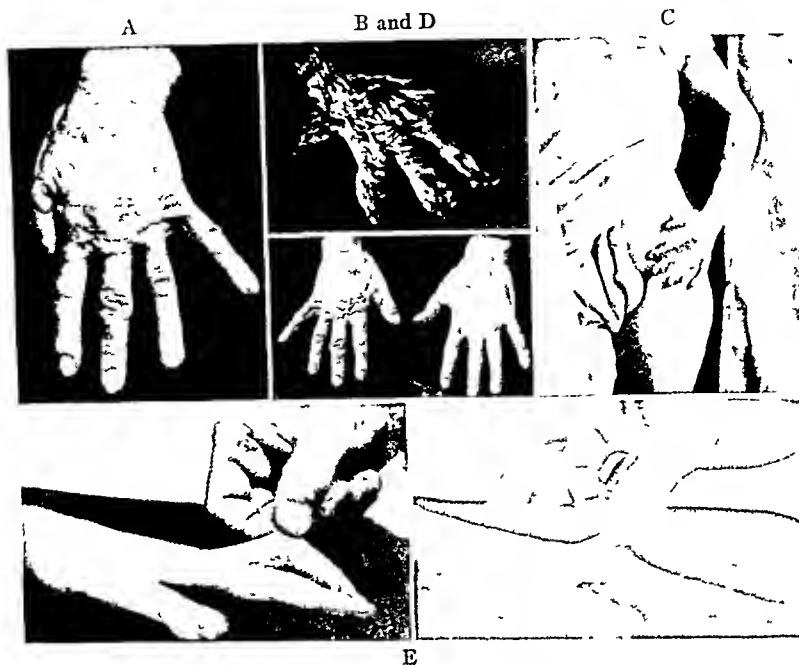


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Fig. 3 For dorsum or palm the double pedicled flap is safest. Its pedicle can not become twisted or linked. A Note how the flap has been cut a little at a time until it is ready to be entirely separated. B The plaster-of-Paris does not give quite enough support. The flap should bear no weight.

type and either may be quite disabling. When the hand is burned in infancy or early childhood and repair of the ensuing contracture neglected or deferred, it must not be forgotten that the involved bones and joints will never develop normally, and that no procedure undertaken after the child has grown up can ever yield such good results as can be obtained when reconstruction is begun as soon as possible. And it is not only the changes in development that occur. Even in adults the joint that has long occupied an abnormal position cannot be restored to its normal position by cutting away the scar. The ligaments on the flexor side become so shortened that they prevent complete restoration and certain intra-articular changes often occur which still further prevent a return to normal. Therefore, all contractures should be treated early.

The skin alone is hardly ever the only tissue involved in the scar. The fascia is, as a rule, the one which causes most trouble, although occasionally muscle shortening may call for a tenotomy, or articular ligaments may have to be cut. In those cases wherein joint changes have occurred, it is better to get good, loose, soft parts first to replace those that were shortened and then attack the joint. The reason is that in flap operations suppuration is not very uncommon, and when joints have been opened this will most likely lead to total ankylosis if suppuration should occur.

How to treat the particular case must always be the chief question. No set rule will

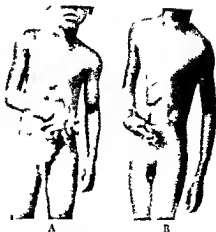


Fig. 4 A The flap is long enough to cover both dorsal and palmar aspects. B After it has adhered to the dorsum it is cut free above and allowed to fall down. The flap then attached to the palmar aspect.

do for all. For some of only slight magnitude a simple removal of the skin scar followed by simple, thick, Thiersch skin graft will do, or perhaps by a whole thickness skin graft. These methods of repairing surface defects have much to recommend them and will always, I think, have a large place in surgery. I feel, each time I use one, that I am performing a new experiment because it has happened repeatedly in my practice and in our surgical service that these grafts have often healed in perfectly and then some time after the eighth or tenth day have begun to die from the surface inward, sometimes the entire graft has been absorbed, and in others absorption ceased before the glandular epithelium has been entirely destroyed. In either case the result was far from good. Then, too, there is the ever present possibility of infection, so many actually take part in an operation besides the patient. And the Thiersch or Wolf skin graft to be successful must be sterile from first to last.

In most instances it is desirable to have fat between the skin and the underlying structures. That is one reason why almost every one has fat so placed. After removal of the scar in those severe contractures about the hands, the feet and the neck, it is highly desirable to have the replaced skin in such condition that it is movable over the under



Fig 5

Fig 5 Flexion contracture of elbow can be benefited by the Z-incision (Fig 6 A, B, C), the division of the bicipital fascia and tendon lengthening (Fig 6 D, E). A transverse uncovered area may remain just in front of the joint (Fig 6 F). A flap from the side at the elbow level with its base forward suffices to fill this (Fig 6G, H).

Fig 6 A, B, and C illustrate the Z-incision. D and E, The flaps have been turned back and a tendon-lengthening done. F, On straightening out the elbow, there is always a transverse area left uncovered after the flaps have been sewed into their new positions. G and H, Such

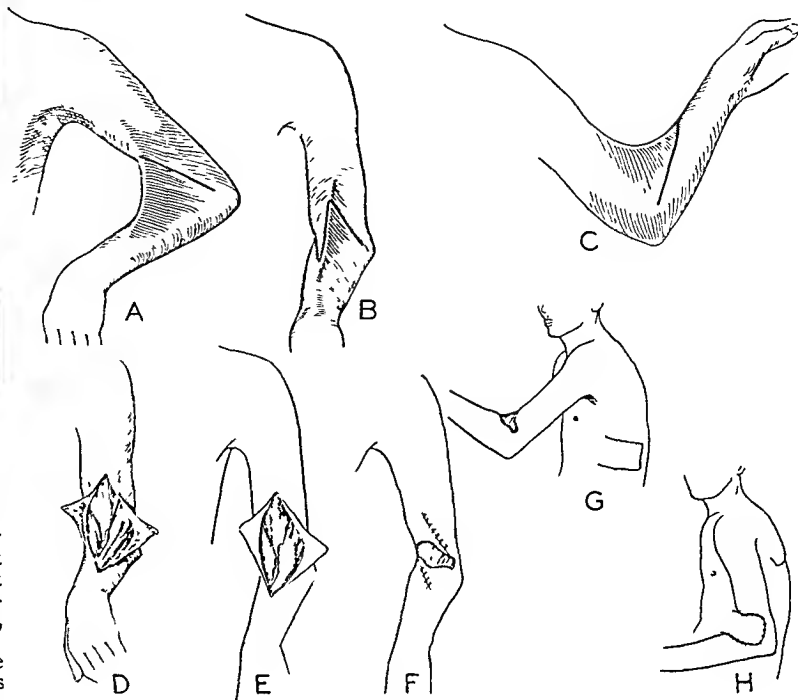


Fig 6

a defect at the elbow is easily covered by a flap from the side, base forward

lying parts and these are mobile under the skin. This is possible only if a layer of fat, or loose areolar tissue, lies under the skin. All the normal fat and areolar tissue have been destroyed and removed. The best method for such reconstruction is by some means of a flap.

When the scar is on the dorsum of the hand, fingers, or wrist, the new parts for repair of the lesion are got from the anterior part of the abdomen or thigh, for the repair of a palmar lesion of hand, fingers, or wrist, from the patient's back or buttock. When fingers are to be covered, separate compartments are made for each finger (Fig 2 C). One should be sure the compartment is larger than the finger, otherwise death of the finger may follow. Or, if the tip of a finger is brought out through a slit in the skin, the slit must not be made so small that sloughing of the finger tip ensues. Again, the fingers are sometimes *sutured in*. This is dangerous as well as painful and hardly ever necessary.

A bit of adhesive to the exposed tip will do. A suture has been tied around the finger and the finger has sloughed. Whole thickness grafts or Thiersch grafts, either thick or thin, do not give such good finger covering (in the author's practice) as those made by means of the flap. All excess fat can be removed easily when necessary and under local anesthesia. The result is a skin covering which is joined to the deeper parts, or separated from these by a layer of loose connective tissue and the skin moves freely on the deeper parts and is not so subject to trauma (Fig 2 E).

When only dorsum or palm is to be cared for the double pedicled flap is safest and its pedicle cannot become twisted nor kinked as can that of the single pedicled one (Fig 3). The beginner usually makes it too thin or fastens it to the hand too tightly and sloughing occurs across the middle with total loss. This is a great calamity. It can be avoided by having it wide enough and long enough so



Fig. 3. For dorsum or palm the double pedicled flap is safest. Its pedicle can not become twisted or kinked. A Note how the flap has been cut a little at a time until it is ready to be entirely separated. B The plaster of Paris does not give quite enough support. The flap should bear no weight.

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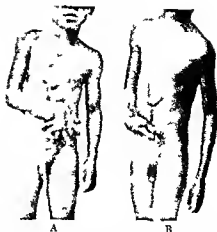


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Fig 9 A, Six months after accident B, Flaps have been wheeled upward and inward after excising the scar below the jaw C, The head is dressed well back D, A flap from the arm (Tagliacozzi) is used to make the lower lip E, But lower lip and chin are still attached to neck A tubed flap (Gillies) is in the making F, The tubed flap has been swung up and is going to replace all of the scar reaching from chin to chest G, The flap has been used twice (note above and below) and is now being used the third time Note lateral view of neck and chin H, This shows what the years have done for him, age 23 Could be much improved by retouching but he "hasn't time"

(Fig 6 F) A flap from the side at the elbow level with its base forward suffices to fill this (Fig 6 G, and H). Such a flap should be at least 2 full inches across at its tip and not less than 3 inches wide at its base. If one has not had experience with this flap he had better begin the making of it before touching the arm. By fastening a piece of cloth to the patient's side and laying it across the arm in front of the elbow on the wound side, he can get some idea from where the flap should be lifted, where the base should remain attached, and where the apex should be. Its outline can then be scratched on the skin and, beginning at the tip, 2 inches of it can be lifted the first day, and replaced and lifted another inch or so in 3 or 4 days. This is repeated until the whole length has been lifted up. It will now be surely viable when transferred to the arm. Closing defects left on the wall of chest or abdomen is usually a very easy matter if one undercuts the superficial fascia and uses strong relaxation sutures.

Cutting a flap free may sometimes be followed by loss of the flap, the part trans-

planted not having sufficiently healed on. This does not happen if clean healing has occurred and if the pedicle has not been cut before 15 days. Trying to hasten the procedure is not always the best way to secure success, and if there is suppuration one had better make sure by waiting at least 3 weeks. By constricting the pedicle with the fingers and watching for color change in the flap, one can tell when the flap becomes viable, for then constriction of its pedicle causes no change of color. When there is any doubt as to the viability of the flap the pedicle or pedicles should be severed slowly. By cutting a little every day or two, Nature seems to make the blood supply answer the demand (Fig 3 A).

A very disabling contracture is that which holds the arm to the chest wall after a burn involving the axilla. The two shown (Fig 7 A, and C) are quite extensive. For those of only slight extent the zigzag incision as in Figure 6 A, B, and C will do. Even a skin graft through a perforation in the middle of the base of the web will suffice. A perforation without a graft allowed to epitheliate through



Fig. 7 For those which involve the upper third of the arm or more a flap of skin and fat gives the best result

B and C Notice the distance that the tip of the flap has had to travel

that the hand can easily be passed under it and then slid up and down for an inch either way. It need not make an exact fit but ought to be wider than the area to be covered. If it is tight at the end of the operation, it will be better to loosen it at that time than later. It is important to have fat enough attached to the flap, and less than half an inch of fat is bad for a beginner. If there is too much fat it can always be removed later, but if too little is left attached to the flap, this will probably die. Another thing the beginner forgets is that such flap sling or pocket must never bear or carry the weight of the hand as a sling does if the patient sits up or goes about. There should be no pressure or tension on a flap (Fig. 3 B).

Sometimes there is scar both on palmar and dorsal aspect of hand or wrist. In these much

time and suffering can be saved by making the same flap do for both surfaces (Fig. 4 A, B). After it has healed on 1 surface the lower end of the pedicle is cut free and the hand rotated 45 degrees, pronated or supinated as the need may be. The scar on the border of the hand is removed and the flap is lengthened and fastened down to this. After another week or 10 days the flap is cut entirely free and long enough to cover the surface remaining to be denuded.

The flexure contracture at the elbow (Fig. 5) can be much benefited by the Z incision, the removal of underlying scar (Fig. 6 A, B, C), the probable division of the bicipital fascia, or even more of the deep fascia and a lengthening of biceps tendon (Fig. 6 D, E). I think a transverse uncovered area just in front of the joint will almost always remain



Fig. 8 A Something must be done at once in order to allow the face and jaws to develop. B A flap is brought from under the chin and the lip and upper part of cheek are unprepared. C A five flap brought from patient's back. Note zigzag line of scar from lip down to chin. A straight line scar will shorten and pull the lip down later. D This is how she has grown up.



Fig 11 A, Patient burned 9 years previously and operated upon elsewhere B, A flap from the back, after being cut free at its lower end, is drawn up many times daily toward the position it is going to occupy, until it can

retain its color It is then ready to apply. C, All of the scar tissue between the surface and the hyoid bone is cut through and the flap is sutured into the raw area Retouching later can make it look much better

I have used this latter kind of flap a good deal for contractures of the lower jaw and I like it better the more I use it Many of these contractures follow burns in childhood (Fig. 8, 9) and something should be done at once, for as the child grows, skeletal deformities

will occur involving the lower jaw, upper jaw and spine and these cannot be corrected afterward

Here again the treatment must vary with the extent of the burn. The zigzag incision (Fig 6 A, B, and C), the thick Thiersch graft

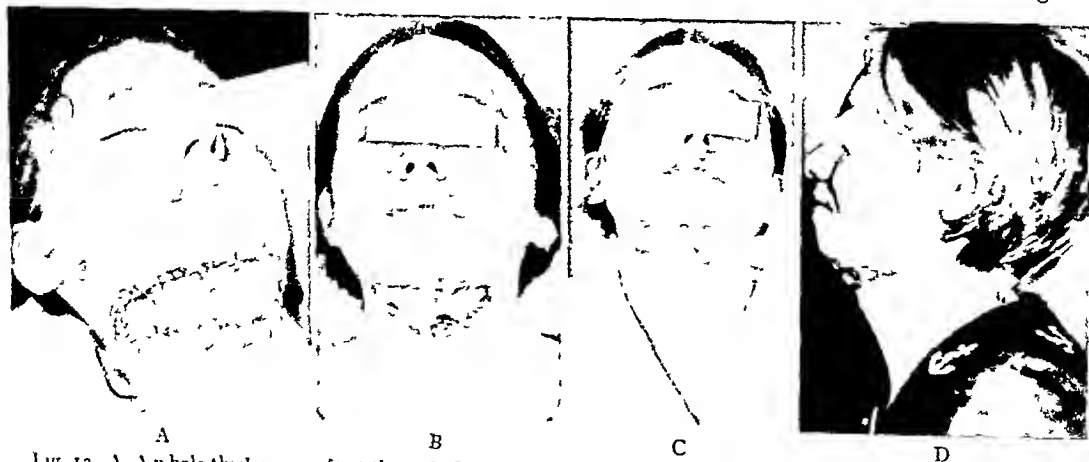


Fig 12 A A whole thickness graft at the end of 5 days It is changing from blue to pink B, the same, 5 days later No infection C, The same Healing has occurred but scar

is still present D illustrates a lateral view of the same patient This has never occurred with any of our pedicle grafts



Fig 10. A and B Condition after treatment with whole thickness graft 3 years previously. C The flap has been raised from the back to conceal the scar. The scar unsightly at first, can be narrowed a little at a time by the

method of New if this seems desirable. D, E, and F illustrate the condition of the patient 3 months later when she returned to the hospital to have a small portion of the flap removed.

along a seton, as the pierced ear does, and then cutting through from this opening to the surface will do well enough when the web is thin and small, as in the case of web fingers. For those which involve the upper third of the arm or more, however, I think a flap of

skin and fat gives the best result. It may be that the flap must come from some distance as in Figure 7 B and C. If so, it may be better to raise it in several steps. At times, indeed so much is burned nearby that nothing short of a tube pedicled flap (Gillies) will do

or the whole-thickness graft may do for the small shallow burns, but they are a waste of time with the more severe cases (Figs 10, 11, and 12). For boys and men sometimes it is very convenient to throw in a flap from good skin near by, in them a scar more or less is of no moment; but for the girl one ought to consider the scar left after raising a flap and if possible keep it out of sight.

The tube-pedicled flap from the back is very satisfactory. It may be that it isn't wide enough to cover the whole area when it is unfolded. This must be foreseen and it can be made long enough so that it may be used again and again, as many as 3 times if necessary (Fig 9 F, and G). Not only this, but it can actually be stretched and made long enough to make up for a certain deficit (Fig 13 C, and F). In this case (Fig 13 D) we lost the open part of the flap because of kinking of the tail on the second night. The patient turned while asleep. What remained was too short to reach and too narrow to cover the

defect. Extension was at once applied and the patient was shown how to increase or decrease the pull and the direction. In about 6 months it reached almost to the other ear and we used it twice (Fig 13 C). In some others we have lengthened the pedicle by hanging a weight on it by day and using the elastics at night. The patients learn to apply these themselves and may telephone and return when ready. One objection is the added time, but this doesn't outweigh the many advantages.

One can get a flap from a closer area and without tubing the pedicle as shown in Figure 14. In this case time was of prime consideration. A large flap was lifted half way up the denuded area, Thiersch grafted, and the flap replaced. In 4 days the remainder was raised and grafts placed under it. At the end of 8 days from the beginning the flap was swung into place and healed *per primam*. It was necessary for the patient to stay in the hospital only 23 days.



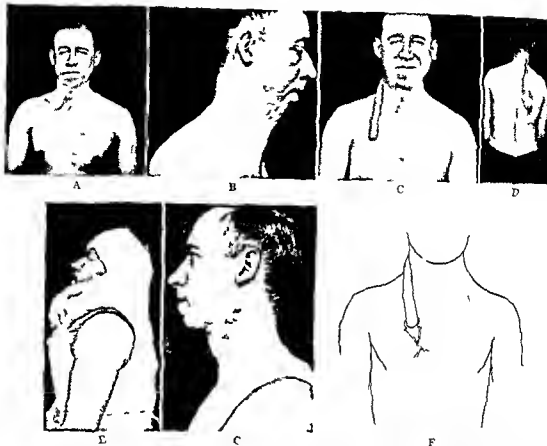


Fig. 13. A and B Patient had been operated upon elsewhere. Burned at 5 years of age. C and D The flap is being lengthened. It was finally long enough to enable us to use it twice. E A plaster of Paris cast is applied to prevent

another catatrophe turning of the head or kinking of the pedicle. F To illustrate the manner of stretching the flap and the manner of gradually bringing it to its new bed. G As he left us.



Fig. 14. A and B Front view and profile to show extent of scar. C The flap is being got from nearby. It has been lifted to one side in order to show the bed. The lower part

of the bed has already been skin grafted. D and E show the scarring and the appearance some time afterward. This was one of the quickest repairs. 23 days.

eral surgeon, fracture surgeon, bone and joint surgeon, orthopedist, or what not. It is fundamentally important that the surgeon, who is best prepared to treat fractures, should treat the injuries of our race. They are those who have given of themselves and who are willing to continue to give service and time in order to study and prepare themselves to bring back the disabled individual to his normal capacity as quickly as possible. Names should be disregarded, a common cause—the individual who has been injured—is to be considered primarily “Disown not your own offspring, yet be not disavowed by your progeny.” This may well be the attitude of surgeons toward those of special groups who attempt to cast out the parent body. They have forgotten or do not know to whom they are indebted for the present high position of the surgeon in relation to fractures. If we were to think in terms of one of Shakespeare’s great plays, the surgeon might be compared to King Lear, who provided for the offspring and then was cast aside as unfit. This seems to be the attitude of some branches of surgery today toward the general surgeon.

#### FRACTURE SURGERY

Let us consider surgery as the application of one’s knowledge of anatomy for the relief or cure of a pathological condition. Let us remember, too, that today’s axioms were mysteries beyond the horizon of yesterday. The horizon had enshrouded the x-ray, bacteriology, and anesthesia. Therefore, surgery could not progress. The evolution of knowledge had not reached out into the field so clearly defined for us today. Surgery of fractures had to stagnate.

With all of our good fortune have we attained the heights which we should have, or have we followed too closely the dictates of the past? Having defined surgery as the application of one’s knowledge of anatomy for the relief or cure of a pathological state, we cannot help but think of surgery as manual in its conception. Fracture surgery is not different from other surgery. It is distinctly, not merely, the treatment of broken bones.

The treatment of fractures implies the utilization of the best knowledge of the sur-

geon, as well as the application of the minute knowledge of our forefathers of surgery. They passed from the degraded position of “barber surgeon,” through the stage of consort to “sack-em-up men,” until today they are the high priests of the suffering, the sculptors repairing the finest work of the Great Architect.

Who were the ancestors of the fracture surgeons of today? In this survey of the evolution of fracture treatment we have elected to begin with the writings of Guy de Chauliac. No matter where one attempts to make his initial investigation he will find literature of value antedating the entrance of his earliest hero on the scene. If we were to accept Hippocratic writings as a starting point, we would become disillusioned immediately. In an epitome of Hippocrates and Galen, published in 1846, by Coxe, we find:

“We cannot in full force of the term admit, that the title of Father of Medicine is justly his due without encroaching on the rights of others, especially since it is incontestably proved by many that these treatises, we admire as his, have really emanated from other sources.”

Hippocrates would not have claimed originality for himself.

“People rather admire what is new, and what is strange they prefer to what is obvious” (Hippocrates).

As a warrant for electing to begin with de Chauliac, I quote from Desault:

“Celsus only copied Hippocrates, adding nothing to his mode of practice. No new method distinguished the surgery of the Arabians. It is necessary to come down to the time of de Chauliac before we meet with the method which is almost universally adopted at present.”

What were the diagnostic signs by which the fathers of surgery recognized fractures, and what were the principles of treatment? de Chauliac taught:

“The signs of fracture are manifest to the senses. If the hand is placed on the region and touches the limb, it finds the part of the bone separated one from the other, and variable, and the figure of the limb abnormal. In palpating with the hand a crackling is heard in the bone, and pain when the spot is touched, and lack of power to sustain it in place.”

Already the pioneer was teaching the value of inspection, palpation, manipulation, and

# THE EVOLUTION OF FRACTURE TREATMENT

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THE evolution of fracture treatment has necessarily been a slow process. The story of fractures through the ages is a definite challenge to the industry and enthusiasm of the present and future generations. As we read yesterday's record preserved by faithful historians, we cannot help but marvel at the powers of observation which enabled the master surgeons of the past to diagnose and treat fractures without the aid of modern scientific adjuncts. One wonders at the temerity of surgeons prior to the introduction of anesthesia. How they were able to reduce deformity caused by fractures without the benefit of anesthesia, will always remain a tribute to the heroism of patients. How simple, in a way, this particular great gift has made the management of these cases is not appreciated by our generation.

From Hippocrates through Galen, de Chauliac even down to the latter part of the nineteenth century, there were lengthy discussions about matters which today even a first year medical student would consider primary information. This information was not available to the greatest surgeons of the past, they had to depend on their knowledge of anatomy and of logic, and based on these alone we find great treatises written on the subject as to whether one position or another was better, or whether one splint or another was preferable. To the credit of the ancients we should say without hesitation, that many of the things which are being rediscovered today were utilized by our forefathers, if not entirely certainly in principle and in many instances they all but stumbled on the things which seem so important today.

*'Hundreds of the profession have derived their celebrity from our general ignorance of the learning and attainments of Galen by stripping the laurels from his honored brow, from which they unduly*

*From the Surgical Department, Touro Infirmary and Charity Hospital*

*Fracture oration before the Clinical Congress of the American College of Surgeons, New York, October 27-28, 1935*

*wreathed a wreath to place around their own altogether undeserving of it'*<sup>1</sup>

Each generation looking back at the history of the past speaks of itself as modern and the older generation as ancient. It is probable that the next generation will think in terms of ours with the same attitude as we look on those of the past. We trust that they will show as much respect for us as we must show to those who preceded us.

Our respect is due to Galen, de Chauliac, Pare, and a host of others who accomplished so much with the only means available, their powers of observation and anatomical knowledge. Their example should stimulate us to emulate them.

It becomes our duty to insist on a greater amount of practical application of the anatomical information which is available.

Our own generation should avoid making use of short cut methods and special gadgets.<sup>2</sup>

*'The very facilities we possess are among the chief causes of our imperfection. Like the hero in the fable, we lie down in repose in full persuasion that the hours of indolence may be easily regained'*<sup>3</sup>

It is our duty to teach fundamental principles, as principles alone should guide us in the management of fractures. We will discuss evolution in terms of principle and not in terms of particular apparatus or particular fractures. If we were to attempt to discuss evolution of the treatment of any one fracture it would carry us too far afield. This discussion will be limited to principles which have to do with the diagnosis and treatment of fractures, bacteriological principles, x ray, and industrial developments, which have done so much toward making our present methods possible.

Let us not think in terms of what a man calls himself, whether he calls himself a gen

<sup>1</sup>The writings of Hippocrates and Galen. Epitomized from the Latin and translated by John Redmond Cose. Published in Philadelphia, 1846.

<sup>2</sup>Magon on 1911. Fundamentals versus gadgets in the treatment of fractures. Fracture Orations. Delivered before the Clinical Congress of the American College of Surgeons, 1935.

femur, and the shortened and retracted appearance of the arm in fractures of the humerus are generally unmistakable evidence of the nature of the accident. The manner in which the patient inclines his head and supports the elbow and forearm in fractures of the clavicle, is too significant to be overlooked by anyone who has ever witnessed it. The peculiar aspect and the attitude of the broken thigh, conjoined with the utter helplessness of the muscles, or the absence of voluntary power are signs which seldom admit of misinterpretation."

It is interesting to compare the careful inspection, palpation, mensuration, advocated by Heister, Cooper, Malgaigne, Desault, Hamilton in 1866, and Gross in 1882, with the hurried advice, "have an x-ray picture taken," so often heard today. These instructions might well serve as a summary of all that was known up to 1895. To our diagnostic armamentarium was added the x-ray in 1895 by William Roentgen.

A review of the literature from de Chauliac to the latter part of the nineteenth century, reveals several salient facts. (1) Diagnosis was based on clinical signs and symptoms, pain, loss of function, crepitus, abnormal mobility, and physiognomy of the part, (2) a knowledge of anatomy was depended upon; and (3) painstaking observations were made. At this point they were forced to stagnate. For nearly 600 years no progress could be made.

Like a beacon across a storm-tossed sea, the light of opportunity burst upon us with the advent of the x-ray. What were some of the results of the introduction of the x-ray? It no longer was necessary to resort to manipulation, for the purpose of eliciting abnormal mobility and crepitus to satisfy one's self that the injured individual had a fracture. In fact, it then became the duty of the teacher, to insist that the traditional crepitus and preternatural mobility should not be sought. Unfortunately, diagnostic acumen seems to have fallen to a low ebb. The surgeons trained before the advent of the x-ray merely used the x-ray as an adjunct and as an essential, added factor, and they trained their students to do likewise.

The powers of observation from which one could note the loss of active motion, the change in the attitude of the limb, plus local-

ized pain, obtained by light palpation, enabled the clinician to indicate nearly accurately where the fracture was and the x-ray was and is used by this group to confirm the diagnosis. For another group, who would take the "royal road," an x-ray is ordered immediately, and action taken on the result reported by the radiologist.

This innovation laid upon us certain obligations, obligations which I fear we have not altogether accepted. The x-ray provided us with a rapid means of diagnosis, but it also directed that we evaluate data not heretofore available, and it clearly indicated that all stored up knowledge gained by experience should not be cast aside. The new data consisted primarily of the visual image. It soon became evident that the visual image of bones varies with age. It became apparent at once to Poland, that a correct interpretation was needed of the appearance of epiphyses at all ages up to adult life so that the normal would not be mistaken for the abnormal. We soon learned that fractures through the epiphyseal lines could not be diagnosed by the x-ray in young children.

In the early part of the paper a statement was made that the ancients all but stumbled on some of the things which seem so important today. One of these has to do with the so called epiphyseal separations. In 1859 Malgaigne stated:

"I rank among fractures these lesions (epiphyseal separations), which some modern authors would consider as distinct from them."

According to Malgaigne, Bertrandi established by dissection the existence of so called separations of the epiphyses. Of course, he had no x-ray, therefore could only philosophize about the nature of the lesion, but he did say:

"When the solution of continuity is on a level and in the same direction with the epiphyseal cartilage the presumption is in favor of the decollation, but certainly can only be arrived at by an autopsy. Consequently aside from the complications the prognosis is the same as for the ordinary fracture near joints."

In 1866 Hastings Hamilton stated:

"Epiphyseal separations we shall not hesitate to class with fractures, and to submit them to the same rules of nomenclature."

mesuration, the importance of pain, change in the axis of the limb, loss of function, abnormal mobility and crepitus

As one further reviews the literature he finds that he has to go down the ages to 1758, to the epoch making work of Heister

'It is no difficult matter to examine fractures of the bone

1 By the eye when the injured part is apparently shorter than the sound, or when you see that the patient cannot make use of it

2 By the touch when you perceive a preternatural inequality of the bone or that it bends in a part where nature never intended it should, and here by the way, we must recommend it to surgeons if it be possible to fix the patient immediately at the first searching of the fracture where he is to lie during the course of the cure

3 By the ear when we hear the ends of the broken bones crush against each other upon moving the limb

In 1832, Sir Astley Cooper stated

Some of the symptoms of fractures are nearly conclusive. The crepitus, the change in the form of the limb and the shortening of it are circumstances common to all the most certain information

America's own William Gibson, in 1832 believed

'In general crepitation is more to be relied on than any other sign, and is an almost certain indication of fracture. Added to this there is usually more or less deformity, pain, swelling, inability to use or move the limbs'

Malgaigne, speaking for French surgeons in 1859 stated

The phenomena to which fractures give rise are cracking heard by the patient at the time of the accident, pain, loss of power in the limb, contusion of the skin, swelling or subsequent preternatural mobility at the seat of the injury, deformity from displacement of the fragments and crepitation. If the finger be passed slowly and carefully over the whole length of the suspected bone unless it has been subjected directly to external violence the absence of all pain and pressure will prove its integrity, on the contrary the existence of pain more or less severe at a circumscribed spot would afford strong presumption of a fracture. More than once from this sign alone I have ventured to diagnose fracture

This attitude on Malgaigne's part of recognizing the importance of localized pain is probably one of his greatest contributions. If that particular teaching were more generally

followed there would be fewer patients treated today for so called sprains

In 1866, Hastings Hammon published his remarkable work, the first of its kind in the United States. From this the following is quoted

'In proceeding to establish a diagnosis in any case the surgeon should sit down quietly and patiently with the sufferer, so as to inspire in him from the first, the confidence that he is not to be hurt or at least not unnecessarily

'He ought then to inquire of him minutely as to all the circumstances immediately relating to the accident in order that he may determine as nearly as possible its cause which alone to the experienced surgeon often affords presumptive if not conclusive evidence as to the nature and precise point of the injury

From this, he should proceed to examine the discolored limb removing the clothes with the utmost care by cutting them away rather than by pulling and when completely exposed should notice with his eye its position its contour the points of abrasion discoloration or of swelling, and not until he has exhausted all of these sources of information ought the surgeon resort to the harsher means of touch and manipulation

Nor will his sensations guide him to the point of fracture by any other methods so accurate as when the patient being composed and his muscles at rest he moves the fingers lightly along the surface of the limb pressing here and there a little more firmly according as a rising induration or elevation may lead him to suspect this or that to be the point of fracture

The limb may now be measured with a tape line and compared with the opposite limb having first marked with a soft pencil or with ink the several points from which the measurements are to be made

Finally if any doubt remains the limb must be firmly but steadily held while the necessary manipulations are performed for the purpose of ascertaining the existence of mobility and of crepitus'

Samuel D. Gross, or the elder, in 1892 stated

There are only 3 symptoms which are at all reliable evidence of existence of fractures, namely crepitation, deformity and preternatural mobility. The co-existence of these symptoms is unmistakably denotive of the nature of the accident. Too much stress cannot be placed upon preternatural mobility as a sign of fracture. Next to crepitation it is unquestionably the most important diagnostic symptom

The physiognomy, or general expression of the affected part often affords valuable diagnostic aid. The deformity for example of the hand and wrist in fractures of the lower extremity of the radius the eversion of the toes in intercapsular fractures of the

"The general treatment of fractures embraces three principal indications. The first is to reduce the pieces of bone into their natural situation (Cooper favored immediate reduction) The second is to secure and keep them in this state. And, the third is to prevent any unpleasant symptoms likely to arise and to relieve them when they have come on."

The interest and enthusiasm of the surgeons of that generation to obtain every available bit of information, so that they could improve themselves in the management of fractures, may be well appreciated by visiting the collections of specimens made by Cooper, Hunter, and others, to be found in the great museums of Great Britain

Strange as it may seem, anatomical knowledge and surgical progress were inhibited by law. Stranger still is the fact that crime paved the way for the study of anatomy. Prior to the Warburton Act of 1832, which legalized the study of anatomy in England, the only subjects legally available for dissection were the bodies of criminals who were sentenced to be "dissected and anatomized." The teachers of anatomy at that time had to purchase bodies from "resurrectionists." These unscrupulous bands of grave snatchers carried their nefarious occupation farther and murder became an active business. One visiting Edinburgh today will see reminders of the activities of this band. The mort-safes in Gray Friars Cemetery bear mute testimony to the work of the "sack-em-up men." The life and usefulness of some of the great anatomists of that day were blasted by public indignation which was aroused by the proof of their association with the purveyors of human bodies. Nevertheless, the desire for knowledge and the hope of rendering service forced the courageous group of surgical anatomists to continue their relations, with resurrectionists

"Sir Astley Cooper's usefulness to the world was based on his profound knowledge of anatomy, and this was gained by the careful dissection of bodies, which were supplied him by the resurrectionists. Thus did the end justify the means."

The modern slogan, "Crime does not pay," was proved when Burke, Bishop, and Williams, were convicted and sentenced to death. Fol-

lowing their execution, public sentiment was sufficiently aroused to permit the passage of the act legalizing anatomical study. An act, which was thought then as now by some as a desecration, has proved to be a consecrating link of the past with the present and future welfare of the human family.

Knowledge of anatomy substitutes safety for boldness and daring. Cooper like many of his contemporaries realized difficulties incident to the management of certain fractures and the utter hopelessness of obtaining good results in certain fractures. This spurred him on in his desire to obtain specimens for study. From a report by Sir Astley Cooper, "On Fractures of the Neck of the Humerus," the following is quoted:

"Let the surgeon do what he will, the head of the humerus will probably remain in the axilla, and the upper motions of the arm will be in a considerable degree lost."

Astley Cooper proved himself more than an anatomist, more than an operator, he was a true surgical philosopher. The advice contained in the following admonition should be heeded by all who believe in the dictum that we should be generous to others and critical of ourselves, for therein lies the attitude which should characterize the unselfish seeker of knowledge

"These cases should teach the members of our profession to be kind, generous, and liberal toward each other, and not to impute to ignorance or inattention that which is the result of a generally incurable accident. It too often happens that when every trial has been made to restore the parts and without success, the patient goes to some other surgeon to whom he shows his arm, and points out its uselessness and want of motion. A jealous and illiberal medical man might say, 'Yes, this is a dislocation which has not been reduced. I wish I had seen it at the first, but now it is too late for a successful attempt to replace it.' However, every intelligent well informed surgeon will now confess that no knowledge or exertion of skill could have prevented the deformity and loss of the natural motion which results from this formidable accident."

This eloquent plea is not only the philosophy of a generous man, but it is almost like a crying aloud in the wilderness for more help in the diagnosis of fractures. Such came with the advent of the x-ray.

<sup>1</sup>Ball, James Moore. Sack-Em-Up Men. Edinburgh Oliver & Boyd, 1925

The discussion still goes on. It is certainly to be hoped that in the near future we will recognize that all epiphyseal separations are in reality fractures. I believe we cannot escape this solution to the problem. We believe that the prophetic statement of the older surgeons on this point might well be adopted and that the term, "epiphyseal separation," be deleted from our surgical nomenclature.

It also became apparent that the hypothetical conditions, reverently spoken of as "sprains," were in most instances fractures. It is devoutly to be hoped that this antiquated term will soon cease to occupy the position of prominence which it does at present.

#### TREATMENT OF FRACTURES

When considering the principles involved in the treatment of fractures, one is confronted by a situation which is well summed up in the writings of John Bell, 1826:

'Ask a young man who has studied his profession faithfully what he would do with a fractured limb? He cannot tell. Ask the same question of one who has practised it well and sensibly. He cannot tell how he himself is accustomed to manage a fractured limb. He has no rule or settled methods. Ask the man of books and study what have been the doctrines of old, or what have been the actual improvements of the modern surgeon, he also is at a loss. Theories, bandages, machines, improvements innumerable, he can well remember, but altogether with these recollections the conviction always rests upon his mind that the subject which he has long regarded as the most interesting is the only one which he has in vain endeavored to understand.

'There is no rule or principle yet established. This is almost the only department of practice which has been continually changing without ever being improved.'

In looking back over the literature we find much that we might quote from the masters of the past. Sound advice given by Hippocrates might well continue to be followed by those seeking to improve methods of treatment of fractures.

'Hippocrates tells us that medicine in all of its branches had been long established that they had found out the principle, and the route of discovery of many excellent things which would serve for the discovery of more provided that those who undertook the task were fitted for it, and possessing a knowledge of what had already been done, would pursue a similar route.

de Chauviac taught the following:

"The general treatment of fractures follows the general intentions of wounds and there are 4 principal intentions. The first is to equalize the bone the second to preserve the equalized bone the third to bind it with callus, the fourth to remedy complications. Before all things, one should prepare all that is necessary for the reduction. The necessary things are: Let one have a cradle or suspensory in which the limb will be firmly and evenly placed, a mattress bed on which the patient sleeps and if it is necessary let it be perforated so that he may go to stool a cord hanging over the bed or some other thing for him to catch and help himself when he wishes to go to stool or turn him self."

Here then are the fundamentals which were possible prior to anesthesia, asepsis, and the x ray. When we would flatter ourselves about recent developments in the general management of fractures it should take no more than the above quoted statement of de Chauviac to humble us.

Sound advice, given by Heister in 1759 with reference to treatment of fractures, is the following:

'The surgeon's principal care in fracture is to unite the broken bones to which three things are necessary: (1) That the bone be restored to its natural situation (2) that after the bone has recovered its natural situation it may be kept there by giving it rest, and applying proper bandages, and (3) you are to use a proper means to prevent or remedy the disorders that usually attend this accident. The knowledge of anatomy is necessary to perform these intentions.

As early as 1803, Desault was pleading for the application of anatomical knowledge and physical principles in reduction of deformity and the maintenance of the reduction. He says:

'All kinds of apparatus for fractures being nothing but resistances opposed by art to the powers which produce displacement it follows that they should all act in directions precisely opposed to the directions of the powers.

If more attention were paid at the present time to such fundamental anatomical and physical principles involved in this admission, there would be less necessity for operative procedures in the treatment of fractures.

Sir Astley Cooper, speaking for the English professor in 1832, stated

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"Hippocrates tells us that medicine in all of its branches had been long established that they had found out the principle and the route of discovery of many excellent things which would serve for the discovery of more provided that those who undertook the task were fitted for it, and possessing a knowledge of what had already been done, would pursue a similar route.

de Cbauliac taught the following:

"The general treatment of fractures follows the general intentions of wounds and there are 4 principal intentions. The first is to equalize the bone the second to preserve the equalized bone the third to bind it with callus the fourth to remedy complications. Before all things, one should prepare all that is necessary for the reduction. The necessary things are: Let one have a cradle or suspensory in which the limb will be firmly and evenly placed a mattress bed on which the patient sleeps and if it is necessary let it be perforated so that he may go to stool a cord hanging over the bed or some other thing for him to catch and help himself when he wishes to go to stool or turn himself."

Here then are the fundamentals which were possible prior to anesthesia, asepsis, and the x ray. When we would flatter ourselves about recent developments in the general management of fractures it should take no more than the above quoted statement of de Cbauliac to humble us.

Sound advice, given by Heister in 1759 with reference to treatment of fractures, is the following:

The surgeon's principal care in fractures is to unite the broken bones to which three things are necessary: (1) That the bone be restored to its natural situation (2) that after the bone has recovered its natural situation, it may be kept there by giving it rest and applying proper bandages and (3) you are to use proper means to prevent or remedy the disorders that usually attend this accident. *The knowledge of anatomy is necessary to perform these intentions.*

As early as 1805 Desault was pleading for the application of anatomical knowledge and physical principles in reduction of deformity and the maintenance of the reduction. He says:

"All kinds of apparatus for fractures being nothing but resistances opposed by art to the powers which produce displacement it follows that they should all act in directions precisely opposed to the directions of these powers."

If more attention were paid at the present time to such fundamental anatomical and physical principles involved in this admonition, there would be less necessity for operative procedures in the treatment of fractures.

Sir Astley Cooper, speaking for the English professor in 1832, stated:

The first reference in a text on the subject of fractures to the Listerian method, we find in Gross's work:

"Whether carbolic acid, apart from the other means, recommended by Lister, is really any benefit in the treatment of those injuries is still a mooted question. A modification of the Lister treatment was introduced a few years ago in the New York Hospital by Professor Markoe, and has given most flattering results, only 1 death resulting in nearly 200."

More important, however, than any detail of treatment one can find is the advice of Gross with reference to fractures:

"There is no class of injuries which a practitioner approaches with more doubt and misgiving than fractures. They frequently involve consequences hardly less serious and disastrous to the surgeon than to the patient himself. If I were called upon to testify what branch of surgery I regarded as the most trying and difficult to practice successfully and creditably, I should unhesitatingly assert that it was that which relates to the present subject.

"I certainly know none which requires a more thorough knowledge of topographical anatomy. As for myself I never treat a case of fracture, however simple, without a feeling of the deepest anxiety in regard to its ultimate issue, without a sense of discomfort, as long as I am conscious that despite the most assiduous attention and the best directed efforts the patient is likely to be lame and deformed for life. A crooked limb, whether rendered so by injudicious treatment or not, is an unpleasant sight to the sensitive surgeon, in as much as it continually reminds him of his bad luck or want of success. I do not wish to be understood to say that it is always in his power to cure these accidents without deformity or impairment of function. Such a view would be contrary to experience and common sense. There are many cases of fracture which do not admit of any other results, however attentively or skillfully they may be treated."

The dissatisfaction expressed by Gross, Hamilton, and others led just a few years later to efforts to improve results. There appeared on the scene Arbuthnot Lane who Moynihan said was, "A man whose mind easily moves along new paths." As early as 1865, Lane began operating on fresh fractures, and for this purpose he used wire. His boldness is an inspiring example of an individual with courage to break away from tradition. He at least had the bolstering influence of the epoch-making work of the pioneers who had introduced anesthesia and of those who had paved the way for a clean surgical wound.

Surgical approach to the subject of fracture diagnosis and treatment had reached an *impasse* prior to the time of Crawford W. Long, in 1842, at which time he introduced ether anesthesia. We marvel at the heroism of the patients and the temerity of the surgeons of the past, who with brute force and "blind flying" attempted reduction of deformities following fractures in the days before anesthesia, and before the introduction of the x-ray. We also marvel at the boldness of the surgeons who before Pasteur and Lister attempted operative treatment of fractures.

As early as 1854 we find that Brainard condemned the use of wires and foreign bodies of every description as a means of promoting the formation of callus. He said: "It is a practice not founded on correct principles and is often dangerous." It should be recalled that this statement was made several years before Lister's application of Pasteur's discovery. Brainard however proved the greatness of his mind in the following statement: "Every method of treatment for ununited fractures appeals to experience in proof of its success."

Time marched on and Lane and Lambotte continued their pioneering break with orthodox methods. What reasons did Lane give for his desire to seek a change? From his own works published in 1905, we quote.

"Experience has taught me to regard the statements in anatomical and surgical work with strong suspicion. It was evident that the displaced fragments of a broken bone were never or hardly ever restored to their normal position, and the so called 'setting of fractures' was a myth. I made very extensive inquiries of medical men, and I was satisfied that the teachings contained in the text books, as to the possibility of restoring the form of broken bones, and the satisfactory results of their treatment were absolutely false."

These words of Lane were written in 1905, but he had evidenced his unrest as early as 1885. This was 10 years before Roentgen's discovery of the x-ray.

#### THE X-RAY

Evolutionary processes go on in the natural order. Man's appreciation of them waits for the unfolding of the secrets in the world about us, and for the practical application of the

We pass from England to France, from 1832 to 1859. In the preface to his treatise on fractures, Malgaigne indicates that his work is the first treatise in the French language limited to the subject of fractures. Malgaigne fulfilled his aim of, "Presenting a resumé of all the doctrines and ideas maintained from the earliest time to our own days, 1859." In vain one searches for a change of method or principle.

A brief resume of Malgaigne's teachings follows.

"The treatment of fractures consists, generally speaking in the fulfillment of two principal indications. To reduce the broken ends and to keep them in place until consolidation is complete.

The proper time for attempting reduction is a question that has presented itself ever since the earliest time and has been variously solved by practitioners. According to Hippocrates extension should be attempted on the first or second day. Boyer and Larrey advocated in general immediate reduction and Velpeau also advocated immediate reduction.

Malgaigne concludes

It is indeed the first day that is generally the most favorable.

Anesthesia is not mentioned under the heading of treatment, and the old discussion of when to reduce was revived. On that point Malgaigne was as definite as surgeons of our own day. In Hamilton's epoch making *Treatise on Fractures* in 1866, the first treatise limited to the subject in America, we find several noteworthy contributions. It is the first treatise in which anesthesia is advocated for diagnostic purposes, and for treatment. He says

I do not often find it necessary to resort to anesthetics for the purpose of insuring quietude and annihilating pain in making these examinations but if the examination is not satisfactory and the diagnosis is important I do not hesitate to render the patient completely insensible.

Hamilton is definitely committed to the plan of immediate reduction.

"Nearly all fractures present 3 principal indications of treatment, namely. To restore the fragments to their place as completely as possible to maintain them in place and to prevent or control inflammation spasms and other accidents. It ought to be regarded as a rule liable only to rare exceptions

that broken bones should be restored to place as soon as possible after the occurrence of the accident.

His advice with reference to transportation of the injured may well be conceded as a fore runner to the instructions given by our transportation committee, namely, "Splint them where they lie," and "gentleness of handling."

Hamilton states

"All that has been said in relation to the propriety of handling a broken limb gently when the surgeon is examining the position and character of the fracture, is equally applicable to the lifting and transporting of the patient to his bed to the removal of his clothing and to the general management of the limb before it is dressed. Rude or awkward manipulations by which needless pain is inflicted are not simply acts of wanton cruelty but they are sources of inflammation suppuration and gangrene. It is difficult to state the precise manner in which the surgeon ought to proceed. Much will depend upon the circumstances of the case something upon one's natural tact and upon the amount of experience but more I think upon the natural kindness of heart and social education. The man of refinement and sensibility will know instinctively how to proceed and needs no instructions. They who lack these qualities can never learn and it would be quite useless to undertake to teach them. I sincerely wish such men as these latter would find some more suitable employment than the practice of a humane art.

Those who believe that the so called Balkan frame and suspension methods are of recent introduction would do well to note the Jenks fracture bed frame described in Hamilton's text, as well as other suspension frames. The after care of fractures with fracture beds containing provisions for bed pans was advocated by Hamilton, and he describes the Daniels fracture bed with such a provision.

In the section devoted to fractures, by Samuel D. Gross the elder, in his *System of Surgery*, published in 1882, we find the indication for treatment of fractures briefly summed up.

The leading indications in the treatment of fractures are to procure reunion and to prevent deformity. It has been a much mooted question whether as a general principle a fracture should be set as soon as possible after its occurrence or whether time should be allowed for the subsiding of the resulting inflammation. It certainly requires no great knowledge of the nature of the accident to discover that such cases should receive the earliest possible attention.

## CONCLUSION

The discussions which have arisen since 1900 with reference to operative or non-operative treatment have had only one objective, to obtain the earliest and safest method of returning the injured to economic efficiency. In order to establish the truth, statistical studies had to be made, since none were available. These were not easily obtained. Statistics, which were presented in the early days, were favorable to one or the other method depending on the source and ability of the surgeons compiling them. It soon became evident that certain fundamental principles had to be applied if the greatest good was to be done. These principles are:

1. In general, conservative treatment applied along anatomical lines was the most successful in the average hands

2. Certain fractures have to be operated upon routinely

3. Direct surgical treatment of fractures should be done only by those qualified by training to operate and equipped with adequate armamentarium

4. Proper hospital facilities are essential

Improvements in x-ray facilities, better surgical technique, and new anesthetic agents have all contributed to the safety of surgery whenever indicated

From the earliest times we find that the masters of surgery taught the value of reduction and immobilization. When to reduce, whether immediately or after variable periods of waiting for the swelling to subside, has provided many arguments. The gist of all discussions at the present time is that attempts at reduction should be made as soon as possible after the accident in simple fractures.

In compound fractures the debate still goes on. Some advocate immediate internal fixation and others direct skeletal traction and suspension. This is a question of experience and not evolution. The evolutionary step is the question of operation as an addition to our portfolio of safe procedures. The safety of this progressive step is dependent upon the

qualifications of the surgeon and the environment provided. This question has been presented admirably by William O'Neill Sherman in a recent fracture oration. It need only be pointed out that direct, operative attack, which resulted from dissatisfaction, was a step in the development of fracture treatment.

In the evolution of the operative procedures by internal fixation many materials have been used and each lauded by enthusiasts. Time alone will answer all of the questions whether absorbable or non-absorbable material should be used, whether autogenous grafts of one kind or another are best; whether grafts are absorbed and act only as a splint and scaffold, or whether they remain permanently; whether one material is irritant, electrolytic, or not. All of these represent the passing show.

The principle of operating in selected cases is, however, a definite stage in the evolution of fracture treatment. Factors, which have made this step possible, are industrial developments, particularly chemical and metallurgical, as well as scientific achievement along bacteriological lines.

It should not be forgotten that fundamental principles of fracture treatment remain the same. They are early reduction and adequate immobilization. The axiom with reference to anatomical knowledge necessary for reduction must not be overlooked.

Will observers in the future credit our generation with progress in principles and practice or will we be charged with having spent our time idly discussing the polemics of who should treat fractures? Traumatic surgery is demanding more and more of our efforts, due to the ever increasing hazardous occupations and modes of transportation. The evolution of the fracture problem depends on continued search for truth and the utilization of all of the aids that scientific achievements place at our disposal for the benefit of the suffering mass of the human family. Let it not be said of our generation that we stagnated, or that we were bound by the adamant force of the authorities of yesterday.

scientific information thus unfolded. Within 1 year of Roentgen's discovery 49 books and more than 1000 scientific and clinical papers were published. The profession had been waiting for someone to lead them from darkness to light. Methods of reduction, which up to the advent of the x ray had been dependent on accurate clinical observation, now had a valuable adjunct. American surgeons, like surgeons in all parts of the world, were quick to realize potentialities of x ray for diagnostic purposes. The effect of the introduction of the x ray on the professional mind is clearly stated by Cattell in 1896:

"No discovery in medicine has equalled its importance since Pasteur, Lister and Koch placed bacteriology on a scientific basis. Who a year ago would have dreamed of being able actually to see the displaced fragments in a Colles' fracture to set the bone to dress the arm and then examine the bone again through the wooden splint and bandages, and note whether or not the broken bones had been correctly approximated? The imagination of the reader is left to discover new fields of usefulness for this most wonderful and practical discovery of Professor Roentgen."

On April 8, 1896, in the *Electrical Engineer* published in New York the following announcement was made with reference to the opening of the Post Graduate Hospital X ray Department:

"Doctors to become cathodographers. Cathodography will shortly become one of the regular features of the Post Graduate Hospital, 20th Street and Second Avenue."

The utility of taking x ray pictures in surgery has been demonstrated so often, that hospital authorities have decided to set aside one of the smaller wards for that purpose and they will equip it with Crookes tubes, Pyraloff coils, sensitized plates, and all other paraphernalia of the new art.

According to Glasser this was the first special Roentgen Department in the United States.

Philip Mills Jones, of San Francisco, and Edward A. Tracy, of Boston, expressed the sentiments of various sections of this country with reference to the new discovery and its usefulness.

"With no discovery within my recollection has the immediate and general excitement been so intense. The application of the x rays in medicine has thus far been confined almost entirely to surgical

diagnosis. Fractures and dislocations, though easy of diagnosis, are sometimes very puzzling. No matter what the natural ability, education or experience of the fingers, they may often be at fault, here, we have an agent that cannot err."

"The fractures and dislocations that have been examined with much profit by this means includes almost every large bone, almost every joint in the body, and no man who has availed himself of this aid in such cases will speak of it in any terms save those of the highest praise."

Edward A. Tracy, in 1897, said:

"The application of Roentgen's discovery necessitates the rewriting of the textbooks on fractures and dislocations. Facts, heretofore 'smothered by surmise,' are clearly set forth by the radiographs."

The United States Army made the x ray an integral part of the Army medical equipment before 1898. In an article by W. C. Borden, published under the direction of the Surgeon General, George M. Sternberg, we read:

"Soon after the discovery by Professor Roentgen the Surgeon General of the Army supplied Roentgen ray apparatus to several of the larger post hospitals. On the outbreak of the war with Spain and the establishment of the general hospitals, the most prominent and important of these hospitals and the three hospital ships, Relief, Misouri and Bay State, were supplied with similar appliances. The use of the Roentgen ray has marked a distinct advance in military surgery."

One can say that the golden age of fracture diagnosis and treatment was born with the advent of the x ray. After the advent of the x ray reduction could be carried out with an accuracy not possible before. Let it be remembered that the x ray did not add a principle but an aid in the carrying out of the fundamental conception of treatment.

That our predecessors realized their limitations is adequately expressed by Cooper, Malgaigne, Hamilton, Gross, Lane, and a host of others. The x ray provided the opportunity for the surgeon to express himself either conservatively or radically. Conservatively, by the application of anatomical knowledge and physical principles, he could reduce a deformity definitely. When this was not accomplished he could safely apply direct exposure of the fracture site and make use of internal fixation for the purpose of assuring the reduction which was thus accomplished.

ing hospitals, it applies to all patient-physician relationships as well. One need only recount the remarks concerning blood pressure readings which may frighten and obsess the patient for days, or the chance remarks that the heart is enlarged, the splenic notch palpable, this or that being better or worse. Under all circumstances one should avoid the practice of ill-considered, tactless discussion of a patient's problems within his hearing. Even with children, lack of tact is fraught with danger, because children often understand spoken language more adequately than adults believe and are able to interpret and evaluate even the most subtle nuances of sign language.

The patient should be comforted, and placed at his ease, and if a foreigner, some attempt should be made to supply a nurse, attendant, or relative who speaks his language. By all means, the untactful use of charts, specimens, roentgenograms, and technical bedside discussions should be avoided. In this respect nurses and attendants should be trained to maintain a sympathetic and tactful attitude in the patient's presence. A simple and understandable formulation of the problem should be given to the patient. This explanation should include reasons for hospitalization, diagnosis, and purpose of operative intervention. These data may be given in such a way that they become reassuring rather than alarming. The introduction to the operating room should be done wisely, again untactful waits in the surgical anteroom with its usual forbidding atmosphere should be avoided.

*Brief personality analysis.* The practising surgeon encounters far too many psychiatric problems in his daily work to permit him to refer all of them to the specialist in mental disorders, nor is this necessary or desirable. We believe that a planned study of the personality factors involved in the various problems greatly enhances the likelihood of successful therapy. Everyone agrees that emotional, social, situational, and kindred factors may cause complications in any somatic illness, but without some systematic knowledge it is difficult to deal efficiently with the mass of facts accumulated by investigation. How, then, may the surgeon equip himself

with the information necessary to enable him to recognize, interpret, and treat the personality disorder that he may meet in his practice? Whether or not the patient is mentally ill before an operative procedure or may become so during or after such a procedure, is not as important as the interested attitude and factual groundwork of the surgeon. We believe that, if surgeons took the time and expended sufficient energy to investigate the past history of the patient, the relevant family data, the origin and development of present illness, the underlying personality of the patient and the signs and symptoms which may appear more or less to be related to the surgical complaint, there would be fewer unnecessary operations, and if intervention were indicated, the patient would be better prepared for it and would experience a much more tranquil convalescence. Incomplete examination and inadequate diagnostic study without evaluation of personality make-up may lead to unnecessary surgical intervention. Let the following case abstracts exemplify what is meant:

**CASE 1** E. F., a white female, 27 years of age, single, was admitted to the medical outpatient department of the Colorado General Hospital on January 11, 1937, and was referred to the Psychiatric Liaison department on March 2, 1937. Her complaints were sudden, abrupt pains all over her body, puffing of various regions of the body, nervousness and depression of mood. Previous operative history was as follows: puncture of left ear drum at 9, tonsillectomy at 10, re-operation of tonsils at 13, nasal septum operation at 13, radium treatment for inward goiter at 13; appendectomy at 14, drainage of gall bladder at 22, puncture of cyst of right ovary at 22, cholecystectomy and right ovariectomy at 23, thyroidectomy at 25, hemorrhoidectomy at 26. Physical, neurological, laboratory and psychiatric examinations were completed and a diagnosis of a tense, depressed, insecure, hysterical personality with somatic conversion symptoms was established. Treatment was both supportive and causal with special care to point out the significance of the emotional factors of domestic incompatibility, worry over increasing age, unemployment and fear of invalidism. Inasmuch as it was necessary for the patient to return to her home in a distant part of the state, only 2 interviews were possible, during which time the patient was able to appreciate the rôle of the emotional factors in her present complaint.

**CASE 2** The patient was a 21 year old, single, white girl, who entered the hospital with the family physician's statement: "Hypothyroidism and ex-

# THE PSYCHIATRIST IN RELATION TO SURGERY

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**S**URGEONS, both as technical operators and as physicians practicing the art of medicine, have often neglected an important phase of their science and art. They have failed to comprehend the *wholeness* of the personality and have been sidetracked into problems of cell or organ function. They have looked upon the sick person as an inert container of offending viscera and not as a reacting person with individual personality functions. Surgeons have failed to recognize that a patient is a unique collection of coordinated functions, an energy system in which every part while performing a special duty is, nevertheless, entwined with all the other functions, and that a change of function in one part is reflected in changes of functions in other parts and in the whole. It is the surgeon's job to remove or alter structures which are defective or diseased. His technical skill in accurate diagnosis and surgical interference is important, but he must know that his personality and the stage he provides may be more important.

What are the facts that will enable a surgeon to prevent or adequately care for the personality disorders which he meets in his work? How can he recognize these disorders if they are present? How can he avoid unnecessary surgery? How can he best prepare and care for the patient before, during, and after the operative procedure? Strangely enough, there is no need for any special equipment and no need for any complicated or cumbersome mechanical or electrical apparatus. The attitude and the facts necessary to deal competently with these problems are within the reach of anyone who wishes to have them and may be set forth as follows: (1) surgeon-patient relationships, (2) time and patience necessary to allow the sick person to tell his story so that one can understand the nature of the individual, (3) appreciation of the fact that not all pain, tenderness, or dis-

ability is organic in nature, and that removal of whatever is associated with the pain will prove to be rational therapy, (4) avoidance of delirious or toxic states by means of judicious chemical sedatives or adequate hydration and nutrition in the postoperative, convalescent state. These are attitudes and facts that should be adopted and utilized.

*Surgeon-patient relationships.* Tact in physician-patient relationships, sometimes called bedside manners, is a matter that is both endogenous and acquired. Unfortunately, in the development of bedside teaching in this country, students patterning their behavior on clinical instructors, even with the best intentions, do not deal with their patients in the most desirable way. Kahn and Powers considered the patients' emotional response to case discussion in a very lucid manner. Among other things they stated:

'The idea has been developing in medicine that physicians are not treating diseases but are dealing with diseased human beings. Doubtless some desirable progress has been made along this line and the fundamental idea seems to be well understood but in clinical pedagogy how is it possible to reconcile one's understanding of the patient as a human being with the teaching necessity of using him as material?'

In his preclinical years the student has been used to dealing with material of different kinds in a very free manner. He had the opportunity to discuss everything perfectly freely with his teacher individually or in a group regardless of the physical presence of the material concerned. When he comes into his clinical years he is confronted with a new situation. The connecting link between him and his teacher is no longer a guinea pig, an anatomical or pathological specimen or a biochemical reaction but another human being. The student is likely to throw himself on the patient with an eagerness similar to that which he displayed when taking hold of a preclinical 'material.' Even if it is as urged that a goodly number of students bring with them to their clinical years sympathetic understanding and much tact, the idea cannot be avoided that the development of their bedside manners will greatly depend on the 'bedside manners' of their clinical teachers.

While these remarks were devoted to a consideration of the patient as he is used in teach-

man will bear with equanimity a wen on his hand or a wart on his nose but a small varicosity in the scrotum will keep him awake at night and depress him during the day I have operated upon many varicoceles to cure a malady that was above the neck "

One should also mention the psychic trauma and concern over the frequent pelvic evisceration in the female and amputation of limbs in either sex. However, the most frequent complications are those encountered in the postoperative phase (2, 12). They may be due to the following: neglect in immediate postanesthetic care in respect to assurance, encouragement, and re-orientation, Preu and Guida recently described the *modus operandi* of postcataract panics, toxic and infectious complications leading to deliriums and other symptomatic psychoses, caused by the unwise choice of an anesthetic, etc; lack of adequate fluid and nutritive factors causing dehydration, ketosis, avitaminosis, injudicious chemical sedation intensifying pre-existing delirious states or actually provoking drug delirium; and failure to inform the patient as to what was done and the result obtained.

The symptomatology of the complications varies in form and content. The following outline may be of value.

*Pre-operative* (1) Pre-existing instability, neurosis or psychosis intensified by hospital admission; (2) development of fear or panic state due to inadequate or injudicious preparation (ill-considered, tactless remarks, demonstrations, etc.)

*Post-operative* (1) Psychoneurotic symptomatology (from monosymptomatic hysterical syndromes to the more diffuse anxiety states), (2) symptomatic psychoses (deliriums due to chemical sedation or to toxins, infection, or malnutrition), (3) the frank psychoses (mania, various types of depression and schizophrenia).

Since drugs definitely increase the tendency to deliriums, a short discussion of the latter will be in place. A delirium may be defined as a disturbed mental state in which disorientation, a predominating effect of fear, and usually a tendency to hallucinations are present. These are closely connected with somatic conditions in that they are dependent upon, or associated with, intoxication, drugs or poi-

sons, nutritional disturbances, circulatory phenomena, and metabolic disorders. These disturbances produce temporary brain changes which are in the nature of edema, or the obscure concomitants of fever, dehydration, and acidosis. The occurrence of delirium should not be considered merely incidental to the principal disease picture. It is a complication that may, and in a great percentage of cases does, interfere with the treatment of the clinical problem in hand. To say the least, it increases the suffering, prolongs the duration of the illness, and may necessitate special hospitalization of the patient, it may even be a personality disorganizing factor of such magnitude as to produce chronic invalidism and incompetency. The delirious patient, befuddled, disoriented, hearing threatening voices, misinterpreting situations, overwhelmed by misgivings and fear and given to action, is in potential and acute danger of injuring himself and even of losing his life by jumping from a window. A very large percentage of deliriums either are preventable or can be ameliorated if recognized early.

#### TREATMENT

Treatment must, of necessity, be preventive as well as causal and supportive. The following points may be of value in stressing treatment possibilities.

1. It is most important to look upon the sick patient as a variously integrated personality rather than a caricature of a diseased viscus. This means that in addition to adequate physical, neurological, and laboratory examinations an attempt should be made to discover and interpret the development and significance of the symptomatology from the points of view of the personal and interpersonal aspects as well as the more tangible impersonal or somatic. This will include a careful differential diagnosis of those physical disorders which are frequently simulated or complicated by psychogenic factors, as thyrotoxicoses, gastric and duodenal ulcers, colitides, etc.

2. Simple, understandable and sympathetic formulations should be given to the patient. These should explain the nature of the immediate hospital environment, the nursing procedures, and the various examinations,



ophthalmic goiter for 12 years exophthalmos, fine tremor, enlarged thyroid, tachycardia. Examination disclosed an anxious, tense girl complaining of shortness of breath, pounding heart and choking sensation in the mid neck region. Her eyes were prominent with some exophthalmos, thyroid was not palpable, resting pulse rate was 84 and blood pressure 100/72. The patient had had an increased appetite but lost 5 pounds in 2 months and was sensitive to cold. The basal metabolism rate showed a minus 18 and minus 23. She had been referred to the hospital for psychiatric opinion by surgeons who rejected the diagnosis of toxic goiter. The patient came from a family in which the incidence of illness was high. She had never been able to carry through plans and responded to failure with temper tantrums and other symptoms. There were marked school difficulties at the age of 10 when she was told by her family doctor that she had a goiter. Her life since had been poorly organized and unproductive of needed satisfactions. With each failure the patient had fallen back on medical support and "goiter." The present illness appeared in a setting of disappointment incident to her being dropped from a beauty culture school after seriously burning a customer. With psychotherapy the patient developed insight was markedly improved and left the hospital to enter work consistent with her abilities.

**CASE 3.** A F 19 years of age was a white female married and the mother of a 4 year old child. She complained of constipation, a drawing sensation in the epigastrium, nausea, and marked belching after meals. Upon examination there was indefinite tenderness in the epigastrium without rigidity. The symptoms had come on 4 years previously. X ray examination showed a duodenal deformity consistent with ulcer free hydrochloric acid 4 per cent total 11.5 occult blood 4 plus in stool. Laparotomy was performed and nothing was found. The study showed the patient to be a rather independent person who had always supported herself. Soon after her marriage she became pregnant and had to give up her job and depend upon her husband's smaller uncertain income. She resented this situation, became anxious about it and developed the above symptoms after the child which increased her responsibilities and accentuated the financial difficulties. When the diagnosis of ulcer was made the patient became body conscious and insecure and this has continued. Psychiatric study and therapy resulted in notable improvement.

These case histories are cited to stress the point that adequate investigation of the endowments and experiences of the personality will go far to prevent unnecessary surgical intervention. Not only will there be fewer unnecessary surgical operations, but fewer residual states of psychic or other invalidism in which the patient usually seeks an outlet for emotional conflict in the form

of bedfastness, an interminable series of operations, hypochondriacal concern over various system functions, and so on.

**Psychosomatic relations.** Much has been accomplished since Hawthorne remarked in the *Scarlet Letter*, "A bodily disease which we often think of as a thing apart and separate, may after all, be but a symptom of an illness in the spiritual part of our nature."

The recent reviews of Dunbar and Witt lower have aided in drawing attention to some of the difficulties encountered in the study of psychosomatic relations. More specifically, the psychogenic aspects of thyrotoxicosis (1, 7a, b), and the disorders of the gastro intestinal tract (7b, 9a, b, 11), have been and continue to be sources of fruitful investigation. In the evaluation of the psychogenic factors 2 elements must be considered first, the underlying personality make up, and second, the exciting factor which may be in personal, personal, or interpersonal.

It is hoped that the recent introduction of psychiatry into the general hospital will serve as a means of teaching physicians and students the need for a more integrated approach to the sick person, as well as offering a fertile ground for further study of the psychogenic aspects of various clinical syndromes (5a).

**Psychiatric complications in the postoperative phase.** In previous communications (5b, c, d), the author has pointed out the most frequent psychiatric complications in surgery and in general practice. We have discussed the courtesy and tact of the surgeon in the pre-operative period. The rôle of the operation, itself, may be an important factor in precipitating or intensifying depressive or anxiety states.

Taylor, a surgeon, corroborated our impression that a disproportionate amount of emotion is aroused in any procedure which concerns the genital organs. Regarding genito-urinary surgery in the male he stated

Many changes may take place in the scrotum. Some of them are of little consequence, some may be disastrous. Not the least thing to be considered is the mental condition that often accompanies any pathological condition affecting the genitals. It is often found necessary to correct some trifling disorder that otherwise would be ignored, to cure a neurasthenia that is wrecking a business career. A

# THE TREATMENT OF OTITIC MENINGITIS DUE TO STREPTOCOCCIC INFECTION BY SURGERY AND SULFANILAMIDE

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ALMOST unbelievable is the improved prognosis in streptococcic meningitis brought about by the introduction of sulfanilamide and its derivatives. Scarcely 3 years ago G. Domagk first reported this valuable form of chemotherapy, and yet the numerous enthusiastic reports in the literature already indicate a vastly improved future for streptococcic meningitis therapy (3, 16, 23, 33, 35, 41). Our pre-sulfanilamide records, as well as those of others, show a depressing mortality of close to 100 per cent for streptococcic meningitis, the type or the earnestness of treatment notwithstanding; whereas the previously mentioned articles indicate an encouraging 20 to 45 per cent mortality. The cases to be reported here, also, substantiate this more hopeful outlook.

The term otitic meningitis implies, of course, a meningitis resulting from a pathological auditory apparatus. Its significance to the otolaryngologist is best shown by a series of autopsies including 110 cases of suppurative meningitis in which approximately three-fourths were shown to have otitic infection as the primary etiological factor (11). To establish such a diagnosis clinically one must rule out by careful history and physical examination (1) any infectious process, local or general, producing the meningitis and antedating the otitis media, or (2) any intercurrent infection which is accompanying a suppurative otitis but which in itself accounts for the meningitis. Not infrequently an ear infection, throwing out organisms to produce a meningitis, is overlooked or more often considered non-surgical because of a lack of clinical or x-ray findings. The practising physician must

learn the lesson vividly portrayed in recent years at the Indiana University Hospitals by 5 streptococcic meningitic autopsies, 3 of which disclosed unoperated upon unilateral or bilateral mastoiditis and otitis accounting for the meningitis.

Our desire is to describe 7 cases of meningitis treated with sulfanilamide and surgery as indicated. Four had hemolytic streptococcic meningitis, 1 a serous meningitis accompanying an acute streptococcic otitis and mastoiditis, 1 a serous meningitis with a Gram positive bacillary otitis and mastoiditis, and 1 a meningitis due to an unknown Gram negative bacillus. It seems warranted first to emphasize briefly salient points concerning streptococcic otitic meningitis and the chemotherapeutic agent, sulfanilamide.

## ETIOLOGY AND PATHOGENESIS OF STREPTOCOCCIC OTITIS MENINGITIS

Obviously by definition such a meningitis results from the entrance of streptococci into the cerebrospinal system from an otitic focus. Such a meningitis tends to be fulminating; however, the actual speed of development depends largely upon the pathway of infection (8).

Pathogenetically, the organisms may travel from the ear to the meninges by direct extension via the eighth nerve, through persisting sutures or dehiscences, through the aqueductus cochleæ or ductus endolymphaticus (27), or through an osseous discontinuity resulting from trauma or operative procedure. The spread may be hematogenous, but probably most common is the propagation by thrombophlebitis from an area of osteomyelitis or periostitis produced by an expanding middle ear infection (10). A true streptococcic meningitis will be suppurative in type although one may have a serous or sympha-

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3 One should avoid untactful remarks, unnecessary phrases or the demonstration of charts and roentgenograms which may startle or frighten the patient

4 One should take care to avoid overdosage of chemical sedatives, to be aware of susceptibility to the various drugs used in basal anesthesia, and to use hydrotherapy whenever possible

5 Toxic and infectious complications should be prevented by due attention to fluid balance and to an adequate nutritive state

6 In unstable individuals, particularly in the psychoneurotic group, operative intervention, in all but emergency conditions, should be postponed. It is in this group of problems that one meets the all too frequent operation for the removal of adhesions. A careful scrutiny of the presenting complaint from all points of view, including that of a brief personality appraisal, will decrease the number of unnecessary operative procedures

7 If operative intervention is indicated in a patient who is manifestly neurotic or psychotic, psychotherapeutic measures should be instituted, if possible, before and after the operation

#### SUMMARY AND CONCLUSION

The attention of the surgeon has been called to the following needs: tact in surgeon-patient relationship, thorough and adequate personality analysis of each patient, appreciation of the rôle that emotional conflicts play in creating, complicating, or masking somatic disease, and the avoidance of postoperative complications by the maintenance of an adequate fluid balance, nutritive state and the judicious prescription of chemical sedation.

This has been a most welcome opportunity to review a few major problems which need the mutual co-operation of the psychiatrist

and the surgeon. Each is a practitioner of the healing art upon the patient, who should not be thought of as a mechanized collection of organs, but as a reacting person with individual personality functions. It is hoped that a wider dissemination of this point of view will lead to greater understanding and to further perfection of methods of diagnosis and treatment in the field of our common interests.

#### REFERENCES

- 1 BILLINGS E G Anxiety syndrome. *Colorado Med* 1937 34 14
- 2 COHN S and McDERMOTT N T Postoperative psychosis. *Med Clin N America* May 1938 21 57
- 3 DeCOSTA J D *Modern Surgery*, 10th ed. Philadelphia W B Saunders Co, 1931
- 4 DENBAR H F Emotions and Bodily Changes. New York Columbia University Press 1935
- 5 ERASER F G (a) Psychiatric facilities in the general hospital. *Am J M Sc* June 1939 194 535 (b) The Toxic Organic Reaction Types. *Oxford Medicine* N Y Oxford University Press 1936 7 (c) Psychiatric complications in surgery. *Bull Am Coll Surgeons* 1937 22 153 (d) Frequent psychiatric complications in general practice. *Am J M Sc* August 1931 194 343
- 6 KARY E and POWERS G F Bedside teaching: Consideration of the patient's emotional response to case discussion. *J Am M Ass* August 29 1936 19, 639
- 7 MOSCOWITZ L (a) The nature of Graves' disease. *Arch Int Med* October 1930 46 610 (b) The psychogenic origin of organic diseases. *New Eng J Med* April 4 1935 212 607
- 8 PEAR P W, and GRIDA, F P Psychoses complicating recovery from extraction of cataract. *Arch Neurol & Psychiat* October 1937 38 518
- 9 SULLIVAN A J (a) Psychogenic factors in ulcerative colitis. *Am J Digest Dis and Nutr* 1936 13, 1 (b) Emotion and diarrhea. *New England J Med* Feb 11 1936 214 299
- 10 TAYLOR C N The scrotum. *South M J* 1933 26 187
- 11 TILLOTSON K J The psychobiological approach to gastro-intestinal disorders. *Am J Digest Dis and Nutr* 1937 4 682
- 12 WASHBURN A C, and CLARK M S Postoperative psychosis. *J Nerv & Ment Dis* November 1935 82 503
- 13 WEITKOWER F Studies on the influence of emotion on the functions of the organs. *J Me t Sc* 1935 81 533

surgery rather than as a substitute for localized drainage. Philosophically, Lewy states, "The elimination of a large amount of surgery now done in otogenic meningitis may be in the offing, but it would still seem advisable to operate until our diagnostic skill is improved, particularly so with chronic ears."

Exposure of the dura to the full extent of involvement has become a widely used procedure, advocated by many. Some (14), on the other hand, are not convinced of its efficacy, and almost all are opposed to opening the dura unless definitely indicated. In such a case it is wise to close over the dural gap with fascia, muscle, or some other tissue so as to avoid a persistent connection with the pneumatized air cells which might serve as a pathway for future infection.

For cerebrospinal fluid drainage the tendency is toward simple, regular lumbar punctures at 8 to 24 hour intervals depending on the amount of intraspinal pressure and cisternal or ventricular taps in the event of block. Lumbar puncture was first introduced in 1890 by Wynter, and cisternal drainage in the following year by Ballance (18). Procedures described since that time have tended to be more radical, a recent example of which is Kubie's method of forced drainage. These more formidable procedures are frowned upon to a great degree (18, 23, 35).

Supportive care plays a major rôle in every streptococcic meningitis recovery. The usual severity of such a case demands intravenous fluids and frequent transfusions according to the indications as well as absolute physical and mental rest. Sedation permits calmness and conservation of energy, an easily assimilative and eatable diet plus ample fluids allow build-up and support. Stimulants of general metabolism and hematopoiesis, particularly leucocytosis, can be of value. Atkinson stresses these points in his pre-operative management of acute streptococcic mastoiditis, but unfortunately with otitic meningitis one cannot wait for mastoid localization, as he advises in treating mastoiditis *per se*, since most of the value derived from surgery is obtained early in surgery.

Fighting the infection by means of serums and chemotherapeutic drugs has made the

greatest recent advancement because of sulfanilamide's introduction. The many types of serum offered on the market are of variable value in therapy. Autogenous serum intraspinally has been recommended highly by some (27), particularly in a slowly responding case. They reason that the blood has attained a fairly high titer by that time, and since the choroid plexus tends to prevent the passage of immune bodies, intrathecal administration of the blood serum should raise the titer in the cerebrospinal fluid.

The therapeutics of sulfanilamide have received bountiful attention subsequently to its advent into medical literature. It probably has shone most brightly in the treatment of streptococcic meningitis. Recommended dosage varies to a moderate degree, but a review of the vast number of reported cases in the literature suggests a considerable amount of agreement among clinicians. Oral and rectal administrations of sulfanilamide are preferred although an 0.8 per cent sulfanilamide solution given subcutaneously and intramuscularly, or subcutaneous prontosil injections, are noteworthy in the vomiting or comatose patient. Intravenous sulfanilamide usage is advised by only a few men and intrathecal administration of the drug is discouraged by Adolph and Lockwood, and others (3 et al.) who reason, that because the streptococci are doing their damage deep in the meninges rather than out in the cerebrospinal fluid, sulfanilamide placed therein can have little effect. Furthermore, the spinal fluid concentration of sulfanilamide approximates closely that of the blood despite the method of administration.

Dosage has more or less regulated itself to around three-fourths of a grain of sulfanilamide per pound of body weight taken orally at 4 to 6 hour intervals, 5 to 50 cubic centimeters of 0.8 per cent sulfanilamide solution or prontosil parenterally at 6 hour intervals or longer depending on the case. Simultaneous dosage of sodium bicarbonate orally or sodium lactate intravenously, if the patient is unable to take alkali by mouth, will combat the acidotic tendency which often develops. We and many others (3, 5, 35) have noted the rapidity with which a patient with impaired renal function will build up a blood sulfanilamide concentra-

thetic meningitis with turbid spinal fluid under increased pressure, increased cell count (usually predominantly polymorphonuclears), and negative albumin, globulin, smear, and culture. A localized suppurative meningitis with an accompanying serous meningitis is also possible.

#### DIAGNOSIS

The history and the physical findings of meningeal irritation plus the laboratory report of the prompt diagnostic spinal tap usually lead to a diagnosis. One must bear in mind and differentiate by the above procedures other possibilities such as meningismus which usually accompanies acute systemic infections, encephalitis, poliomyelitis, and benign lymphocytic choromeningitis, acute syphilitic meningitis, subarachnoid hemorrhage, localized suppurative meningitis, and serous meningitis (46). The latter 2 conditions and a generalized suppurative meningitis tend to come into the hands of otolaryngologists because etiologically there is often an underlying otitis, mastoiditis with associated epidural abscess, or sinus thrombosis.

The spinal fluid in streptococcal meningitis is characteristically turbid under increased pressure, elevated cell count, and polymorphonuclears predominating as a rule. The cloudiness is produced by the resultant irritative tissue exudation (10) thereby serving partly as a guide to the case's progress. The albumin, globulin and lactic acid are variably increased. A typical meningitic gold curve will usually be obtained. Serology, smear, and culture are valuable in differentiation, and the streptococci will eventually be found thus if they have broken out of the original focus in sufficient number and if permitted to multiply. Degenerative forms of streptococci and certain other pathogenic organisms may appear Gram negative.

Other laboratory work such as urinalysis, blood count, and the like must be considered in evaluating a case. To follow a patient's progress adequately one can follow the suggestions of Maxwell in the management of otitic sepsis. He advises observing frequent pulse, respiration, and temperature readings, following daily blood counts, urinalyses with centrifugate smear study, and blood cultures,

examining the patient often, and ordering chest x ray examination, etc., when indicated. The good clinician never forgets that the sick patient, as one with meningitis for example, may contract some other pathology to complicate the picture.

Streptococcal meningitis calls for prompt diagnosis and treatment. One must not delay in performing a diagnostic spinal tap carrying through any surgical procedure that is indicated, and instituting other therapeutic measures. A few hours of procrastination may greatly affect the prognosis. Persistent headache and developing meningeal irritation in the presence of otitis and mastoiditis calls for immediate action particularly so with a sclerotic or poorly pneumatized mastoid in which the easiest pathway for the infection is toward the meninges.

#### TREATMENT

Therapy in streptococcal meningitis, as noted, demands prompt, logical action. Here, as in numerous phases of medicine, one finds a wide variation in the recommendations proposed by different successful clinicians. An article late in 1937 (27) reviewed extensively the multitude of therapeutic procedures which have had their day or are now in vogue. Nevertheless most of the recent literature indicates that the majority subscribe mainly to the fundamental objectives of (1) educating the etiologic focus, (2) draining the cerebrospinal fluid regularly and frequently, (3) neutralizing infection with serums and chemotherapeutic agents, and (4) supporting the patient conscientiously.

Removal of the primary focus usually calls for surgery, which must be adequately complete for each particular case. Whether one does (1) a simple mastoidectomy, (2) a radical mastoidectomy, (3) an uncovering or opening of the lateral sinus, (4) a wide exposure of the dura, (5) a labyrinthotomy, or (6) a revision of the entire operative field when the meningitis follows surgery, depends upon the case history, examination, and findings at operation. The introduction of sulfanilamide has been hailed by some as a possible substitute for surgery in these cases. Far more logically, sulfanilamide should serve as an adjunct to

of sulfanilamide than does the blood due to a concentrating power of the mammary gland; and (3), the drug, when given to a pregnant woman, reaches the placenta and may account for increased fetal mortality and morbidity.

#### DERIVATIVES OF SULFANILAMIDE

Although vast numbers of sulfanilamide derivatives have been tried experimentally and clinically, the original product appears far ahead at present in effectiveness and applicability. The derivative running a close second is prontosil and its concomitant usage with sulfanilamide receives considerable comment in the literature. Neoprontosil has been found to be apparently less toxic clinically and a worthy substitute for sulfanilamide although absorbed more slowly (5). The same clinical series found di-methyl-di-sulfanilamide less toxic in general usage except for a peripheral neuritis developing in approximately 6 per cent of the cases. This drug was, therefore, not used further. Neoprontosil yields only one-fourth its weight in sulfanilamide so that Applebaum feels that its therapeutic action results from some other factor besides sulfanilamide. He recommends its use orally as well as a combination therapy with the less complex sulfanilamide.

Enumeration of further instances of satisfactory sulfanilamide therapy as reported in the literature includes cases of erysipelas, pneumonia, scarlet fever, streptococcal sore throat, adenitis, urinary infections, sinusitis, and many others (17 et al.). Of almost unquestionable value is its administration in streptococcal otitis media and mastoiditis, particularly in the prevention of complications therein (2).

On the other hand an attempt to clear up several cases of positive streptococcal throat carriers proved disappointing (21). A still more varied application of the drug is found in the recent reported satisfactory treatment of ulcerative colitis with neoprontosil (5). No doubt, in final analysis, such ardent widespread application of the drug will be unwarranted but at present no one can be criticized for trying it in certain conditions, particularly those for which past therapy has proved discouraging.

#### TOXICITY OF SULFANILAMIDE AND ITS DERIVATIVES

Medical history relates again and again the consequential disasters which almost invariably follow the introduction and extensive application of a drug greeted with such enthusiasm as was sulfanilamide. Complications therewith obtained a head start through the unfortunate "elixir of sulfanilamide," which later was proved to have brought about so many fatalities because of its solvent, diethylene glycol (15). No doubt, to prevent such mishaps any future therapeutic agent should receive exhaustive experimental tests for toxicity, compatibilities, and the like, prior to its acceptance by the medical profession; and yet, experimentation progresses cautiously and painstakingly, whereas enthusiastic therapy too often runs hog wild.

Even though the drug has many toxic manifestations, fortunately most of them are not serious, regrettably, the mechanisms producing many of them are not known. Experimentally, with mice, rabbits, dogs, and human marrow cultures, no permanent tissue damage could be demonstrated after an average dose (31, 36). Possible toxic manifestations are, namely, malaise, anorexia, nausea, vomiting, tinnitus, dizziness, mental confusion, cyanosis, fever, abdominal cramps, diarrhea, hepatitis, nitrogen retention dermatitis, anemia, thrombocytopenia, and perhaps others. The "drug fever" usually appears after a week to a week and a half of therapy. As to the incidence of these, it is impossible to formulate any complete statistics, however, in a series of 114 consecutive cases of beta-hemolytic streptococcal infections treated with sulfanilamide by Hageman and Blake (17) such toxic complications occurred in 56 per cent, with cyanosis being by far the most common. Whether some of these in the future can be prevented in a similar manner, as is acidosis with its resultant cyanosis now avoided by the concomitant administration of alkali, rests with future experimentation. Some acetyl sulfanilamide is produced from absorbed sulfanilamide, and data indicate that it is more toxic than sulfanilamide itself (31).

The toxic reactions enumerated are soon relieved almost invariably by discontinuing

tion This factor plus the several toxic manifestations customary with this drug group must always be borne in mind regardless of the dosage being used

Sulfanilamide has been proved to be of value in treating experimentally induced streptococcal meningitis in white rats (2), rabbits, and monkeys (25) Other recovered cases of otitic streptococcal meningitis treated clinically with sulfanilamide and mastoidectomy as indicated are cited in the recent literature by authors other than those mentioned (13, 17, 38, 42, 44, 45) Among numerous other articles are complete recoveries reported for a case of otogenic meningitis due to an anaerobic Streptococcus haemolyticus beta (43) and a case due to a non hemolytic streptococcus (30) Experimentally in monkeys and rabbits (25) and clinically it appears encouraging in pneumococcal meningitis when used conjointly with specific type serum (3, 35), and may prove helpful in the future in treating meningococcal and influenzal meningitis The drug's great success in otogenic meningitis may warrant its usage in the future as an empirical treatment, despite negative spinal fluid cultures (26)

#### PHARMACOLOGY OF SULFANILAMIDE AND ITS DERIVATIVES

Of chief interest is the mode of action of sulfanilamide about which there has appeared much ado in recent literature Long and Bliss (28), American pioneers in this momentous therapeutic advancement first described the effectiveness of the drug as being due to bacteriostasis which in turn promoted phagocytosis by the polymorphonuclear cells early in treatment and by the monocytes later Further experimentation by these workers (29) strengthened their original conclusions and promoted the theory that retarded streptococcal proliferation lessened the output of leucocidins and similar toxic products, thereby aiding phagocytosis

Based upon widely varied clinical and experimental observations, other men (22, 25) have arrived at conclusions basically similar to those of Long and Bliss However, some have maintained that the primary effect is a neutralization of the organismal toxins, i.e.

aggressins, leucocidins, and other antiphagocytic substances (36, 37) To improve the tenability of this viewpoint Osgood and Brownlee (36) remarked "Clinically its (sulfanilamide's) rapid alteration of the course of erysipelas, streptococcal meningitis, etc., is more easily explained on the basis of neutralization of toxin than on the basis of a bactericidal action" Contradictorily, others (26) disclaim any antitoxic mode of action but instead stress the slowing effect on streptococcal multiplication and metabolism which in turn accounts for decreased toxin formation Still others (2, 45) have published their experimental work disproving the theory that increased phagocytosis plays a part in sulfanilamide action Working with white rats and mice they could show no evidence of increased phagocytosis by either the leucocytes or cells of the reticulo endothelial system Clinical observation indicates that the effect of the sulfanilamide apparently is independent of the leucocytes since a developing leucopenia is the rule and there occurs no proportionate increase in the polymorphonuclear cells (7) Hedging on the issue, we are inclined to believe that sulfanilamide furthers bacteriostatic, bactericidal and antitoxic action, thus reinforcing the body's own mechanisms to eradicate certain types of infection

As to sulfanilamide's effective concentration the use of human marrow cultures showed a 1:100,000 concentration to be as efficient as any against the streptococcus (36) Now, such a proportion is easily obtained by the accepted administration of sulfanilamide and can be maintained by doses at approximately 6 hour intervals, because in the average case the maximum blood concentration is reached in 4 to 6 hours Within recommended dosage the blood sulfanilamide percentage will be roughly proportional to the amount of drug given provided no impaired urinary excretion exists, as noted Hepatic damage or moderately severe anemia likewise warrants extra precautions to prevent dangerous concentrations Noteworthy, also, are a few observations concerning excretion (1) (2) Sixty to 70 per cent of absorbed sulfanilamide leaves via the urinary tract, (2) in the lactating mother the milk carries a higher concentration

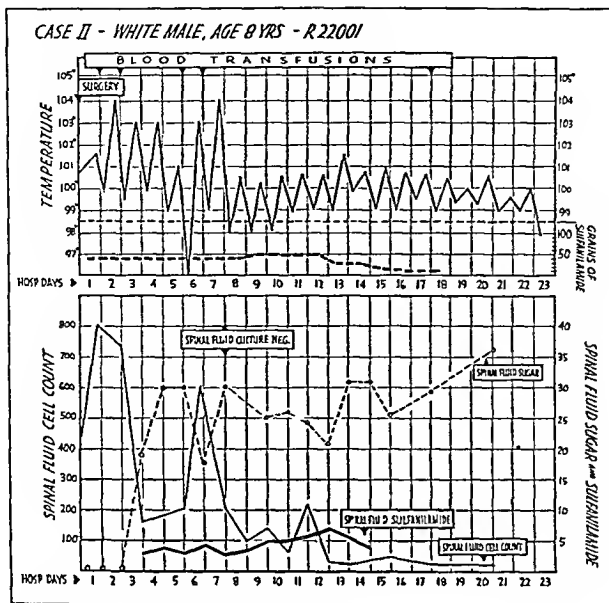


Fig 2 Case 2 An acute hemolytic streptococcal meningitis, mastoiditis, and otitis media complicating scarlet fever

Symptoms grew progressively worse. The past history was negative except for frequent bilateral suppurative otitis. Examination on admittance showed the patient to be acutely ill and irrational, with right ear drainage, right mastoid tenderness, infected tonsillar crypts, dental sordes, neck rigidity, and absent patellar reflexes. On the day of admittance a right mastoidectomy was performed. Pus was found together with extensive bone necrosis. The dural plate of the middle fossa was involved, and a wide exposure of the dura as well as of the lateral sinus was performed. Sulfanilamide was administered rectally and later orally. Frequent spinal fluid drainage was performed and general supportive measures used. The patient had a good recovery and was discharged on July 18, 1938. The laboratory findings were as follows: white blood count on admittance 19,400, red blood count 3,800,000, urine negative except for few hyaline casts and pus cells; spinal fluid cell count 2,290 with elevated globulin and lowered sugar, 3 positive hemolytic streptococcus cultures, x-ray of right mastoid showed increased density and sclerosis. The final diagnosis showed (1) mastoiditis and otitis media, acute right *Streptococcus hemolyticus*, and (2) meningitis, *Streptococcus hemolyticus*.

CASE 2 No 22001, J F, male, white, aged 8 years. The patient, an emergency case, was brought to Riley Hospital on March 3, 1938, with headache, draining right ear, backache, and occasional vomiting. The onset had occurred 23 days before with bilateral earache, 2 days later scarlet fever rash was noted, and bilateral aural drainage started 3 days

afterward. Sulfanilamide was administered by a local doctor. After 1½ weeks frequent headaches occurred. This and other symptoms were severe for the last 2 days before admission. Two years previously both ears had been draining. Examination on admittance showed a desquamating skin, purulent right otitis, and right mastoid tenderness

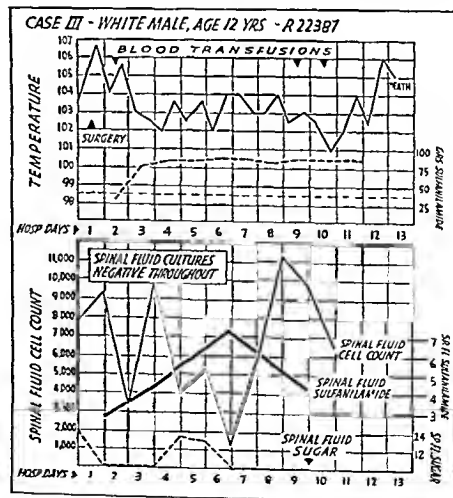


Fig 3 Case 3 An acute hemolytic streptococcal meningitis following a unilateral mastoiditis and terminally developing a suppurative labyrinthitis



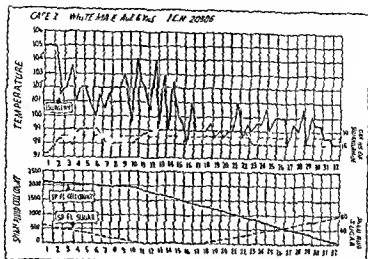


Fig. 1. Case 1. A hemolytic streptococcal meningitis resulting from an acute hemolytic streptococcal otitis media and mastoiditis.

the sulfanilamide. Graver complications, which appear more like drug idiosyncrasies, happen all too frequently for comfort, judging from the numerous reports in the literature. Six or more cases of fatal granulocytopenia have been reported due to sulfanilamide or prontosil; these reports demonstrated maturation arrest in the bone marrow and phagocytosis of iron pigment, representing a hemolytic type of anemia (6, 40). At the Indiana University Hospitals we have experienced only one such case which ended miraculously in recovery.

Another serious complication, acute hemolytic anemia occurs occasionally and, like most drug idiosyncrasies, develops as a rule with surprising rapidity. Judging from the several cases cited in the literature (10, 24), one can expect satisfactory recovery after withdrawal of the drug and one or more transfusions. Much more commonly a patient develops a maculopapular dermatitis 1 to 3 weeks after the first dose of sulfanilamide which clears with some desquamation over a period of days to weeks after the drug is discontinued. Other toxic symptoms tend to precede the skin rash so that this toxic manifestation can frequently be prevented by reducing the dosage, or, if possible by stopping the drug's administration. Severe cases of dermatitis medicamentosa from sulfanilamide

have been described during the past year (12, 34, 39).

This discussion concerning sulfanilamide toxicity emphasizes the necessity for continued observation of the patient in order to note the appearance of any early toxic manifestations. The latter should serve as danger signs to promote a closer check on the patient's general condition, hemoglobin readings and blood counts. Beware of a developing leucopenia or anemia!

#### PRESENTATION OF CASES

The accompanying tables represent in the upper graph the patient's temperature course, the day when surgery and transfusions were performed, and the daily sulfanilamide dosage. The lower graph in each table shows the spinal fluid cell count, the spinal fluid sugar, and the blood or spinal fluid sulfanilamide concentration in milligrams per 100 cubic centimeters of blood.

Four cases of proved hemolytic streptococcal meningitis were treated with mastoid surgery as indicated and sulfanilamide.

**CASE 1:** No. 20506 L. McC., male white, aged 6 years. The patient an emergency case was brought to the Indianapolis City Hospital on June 25, 1938, with right aurial pain and drainage, high temperature and irritability. Earache had begun 4 days before and spontaneous drainage the next day.

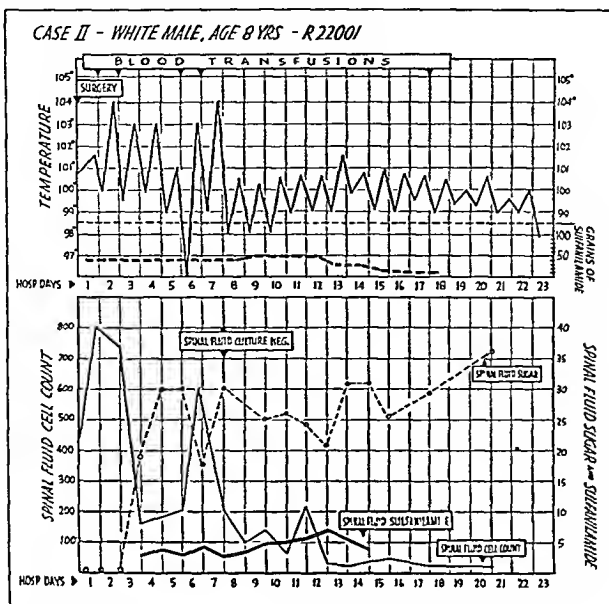


Fig 2 Case 2 An acute hemolytic streptococcal meningitis, mastoiditis, and otitis media complicating scarlet fever

Symptoms grew progressively worse. The past history was negative except for frequent bilateral suppurative otitis. Examination on admittance showed the patient to be acutely ill and irrational, with right ear drainage, right mastoid tenderness, infected tonsillar crypts, dental sordes, neck rigidity, and absent patellar reflexes. On the day of admittance a right mastoidectomy was performed. Pus was found together with extensive bone necrosis. The dural plate of the middle fossa was involved, and a wide exposure of the dura as well as of the lateral sinus was performed. Sulfanilamide was administered rectally and later orally. Frequent spinal fluid drainage was performed and general supportive measures used. The patient had a good recovery and was discharged on July 18, 1938. The laboratory findings were as follows: white blood count on admittance 19,400, red blood count 3,800,000, urine negative except for few hyaline casts and pus cells, spinal fluid cell count 2,290 with elevated globulin and lowered sugar, 3 positive hemolytic streptococcus cultures, x-ray of right mastoid showed increased density and sclerosis. The final diagnosis showed (1) mastoiditis and otitis media, acute right *Streptococcus hemolyticus*, and (2) meningitis, *Streptococcus hemolyticus*.

CASE 2 No 22001, J F, male, white, aged 8 years. The patient, an emergency case, was brought to Riley Hospital on March 3, 1938, with headache, draining right ear, backache, and occasional vomiting. The onset had occurred 23 days before with bilateral earache, 2 days later scarlet fever rash was noted, and bilateral aural drainage started 3 days

afterward. Sulfanilamide was administered by a local doctor. After 1½ weeks frequent headaches occurred. This and other symptoms were severe for the last 2 days before admission. Two years previously both ears had been draining. Examination on admittance showed a desquamating skin, purulent right otitis, and right mastoid tenderness.

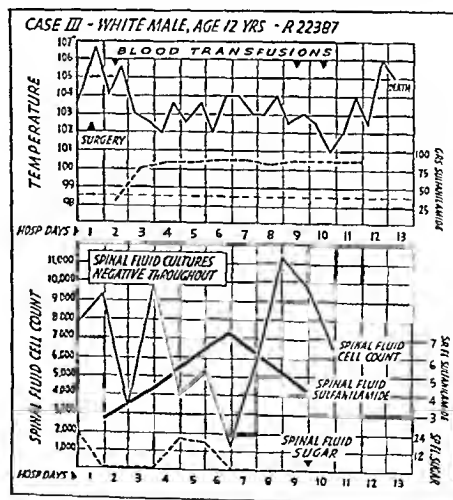


Fig 3 Case 3 An acute hemolytic streptococcal meningitis following a unilateral mastoiditis and terminally developing a suppurative labyrinthitis

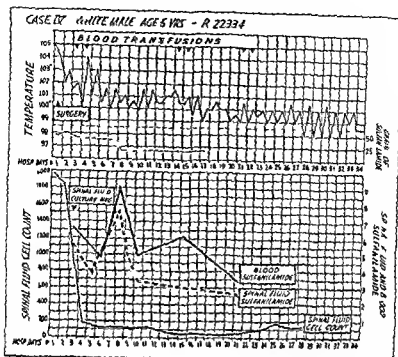


Fig 4 Case 4 An acute unilateral hemolytic streptococcal mastoiditis with a superimposed hemolytic streptococcal meningitis

There were positive neck leg and contralateral leg signs. A prompt right mastoidectomy was performed but no evidence of dural perforation was found. The lateral sinus was exposed and the wound drained and closed. Thirty five grains of sulfanilamide was administered orally for 8 days. 45 grains 4 times daily and then tapered off dosage during next 6 days. Eight tenths per cent sulfanilamide solution was administered intrathecally 12 times 3 to 4 grains each time. There were also 4 transfusions. Frequent fluid drainage and other supportive measures used. The patient had an uneventful convalescence and was discharged with healed wound and dry ear on March 15 1938. Laboratory tests showed urinary casts and pus cells at first, white blood count 14 600 to 20 300 to normal, spinal fluid count 800 sugar too low to read elevated globulin and protein meningitic gold curve, 7 positive cultures and smears for Streptococcus hemolyticus and the right mastoid bony on x ray. The final diagnosis revealed (1) mastoiditis and otitis media, acute hemolytic streptococcus, (2) meningitis, hemolytic streptococcus and (3) scarlet fever convalescent.

CASE 3 No 22367, J D D male, white aged 12 years. This patient was an emergency admission to Riley Hospital on April 27 1938. He had frontal headache draining right ear and was irrational. Two and one half weeks before he had had tonsillitis and a week later suffered with headache and earache. Two days later a local doctor removed a bean from

the right ear canal. There had been bloody and purulent drainage since. Four days after the patient showed meningitic signs and had been irrational for the 4 hours previous to admission. Examination on admittance showed a thick purulent drainage from the right ear, and the patient was stuporous. There were positive neck and leg signs. Babinski was positive on the left, but there were absent patellar and Achilles reflexes. On the first day a simple right mastoidectomy was performed at which time pus and a tense infected dura were found. Sulfanilamide was given orally from the second day on. The course was steadily downward. Nasal oxygen being used during the last 2 days. The patient died on May 9 1938. No autopsy was performed but an examination of the mastoidectomy was permitted. A subluxation of stapes and a suppurative labyrinthitis were found. The laboratory findings were as follows: white blood count 18 800 to 37,800 to 31 600 hemoglobin 15 to 9.5 red blood count 4 370 000 to 3 330 000 urine contained albumin spinal fluid count 7 600 to 9 810 to 5 600 with a high polymorphonuclear percentage increased globulin and protein no sugar meningitic gold curve. Cultures and smears were positive persistently for Streptococcus hemolyticus. Highest blood sulfanilamide

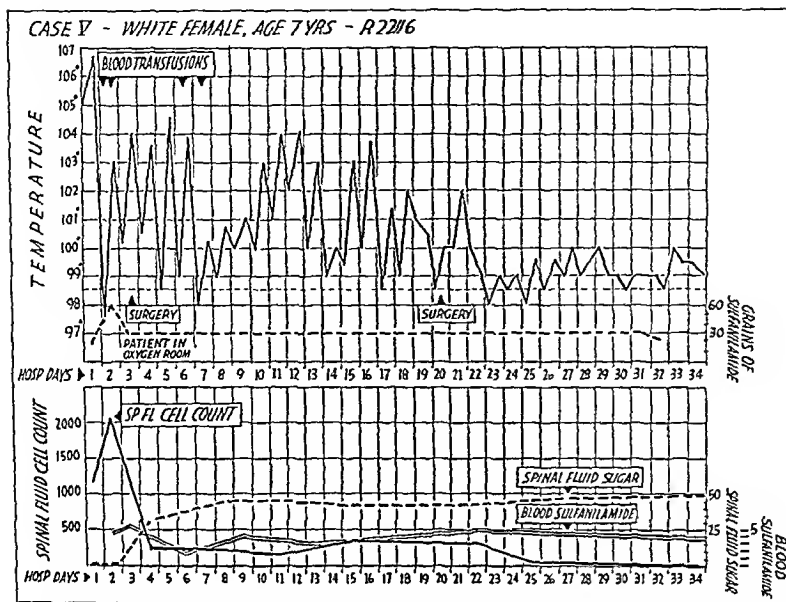


Fig 5 Case 5 A serous meningitis accompanying an acute unilateral streptococcal otitis and mastoiditis, complicated by a petrositis of the same side and bilateral bronchopneumonia

percentage was 8.8 milligrams. The final diagnosis revealed (1) acute mastoiditis, right *Streptococcus hemolyticus*, (2) meningitis, *Streptococcus hemolyticus*, and (3) right, suppurative labyrinthitis.

**CASE 4** No 22334, R D, male, white, aged 5 years. This was an emergency case brought to the Riley Hospital on April 20, 1938. The patient had a pain in neck, headache, and leg ache which developed during the 3 days previous to admission. There had been right ear drainage for 10 days, and urinary frequency was noted during the last 24 hours. Examination showed right ear draining, left drum white and bulging, patchy exudate on large tonsils, marked adenopathy on the right, and typical meningitic symptoms. A left myringotomy and right simple mastoidectomy were performed immediately. Necrotic bone, overlying the lateral sinus, and a tense and injected dura were found. The patient was started on oral sulfanilamide and given transfusions, supportive treatment, intravenous fluids, etc. Repeated lumbar punctures were done as the patient gradually improved. Two months later he required a left simple mastoidectomy. The patient received 4 x-ray treatments to mastoids and improved. He was discharged July 26, 1938. Laboratory findings were as follows: white blood count 22,500 with 82 per cent of polymorphonuclears on admission, non-protein nitrogen .48, spinal fluid cell count 1800 with high polymorphonuclear percentage to 1,976 to normal, increased globulin and protein at first, positive cultures of spinal fluid, blood, and ear for *Streptococcus hemolyticus*. The highest blood sul-

fanilamide percentage was 90 milligrams, blood counts became normal except for a mild secondary anemia, pus cells and casts in urine cleared. The final diagnosis revealed (1) mastoiditis, acute, right *Streptococcus hemolyticus*, (2) meningitis, *Streptococcus hemolyticus*, and (3) mastoiditis on the left.

Two patients with serous meningitis, resulting from an acute unilateral otitis and mastoiditis, recovered with surgery as indicated, sulfanilamide, and general supportive measures. Etiologically the otitic infection in one was due to the streptococcus, and in the other to a Gram positive bacillus.

**CASE 5** No 22116, B C, female, white, aged 7 years. The patient, an emergency case, was admitted to Riley Hospital on March 16, 1938, with headache, vomiting, fever, neck rigidity, and coma. The onset occurred 9 days previously with headache and right earache. Nausea and vomiting followed the next day and 2 days later irritability and neck rigidity were noted. Two days after the right drum drained spontaneously and irrationality and coma developed. Examination on admittance showed the patient to be acutely ill, cyanotic, comatose, with right lateral rectal weakness, bulging right drum, positive Kernig's, Babinski bilateral positive, and evidence of bilateral bronchopneumonia. The patient was placed in the oxygen room. After 2 transfusions and other supportive measures a right simple mastoidec-

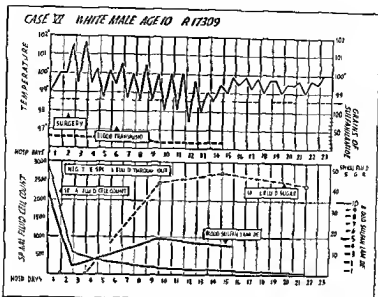


Fig 6 Case 6 A serous meningitis with an acute unilateral mastoiditis and otitis media due to a Gram positive bacillus

tomy was performed under local anesthesia on the third day. There was very little bony destruction and the lateral sinus and dura were not exposed. Oral sulfanilamide was given and the patient improved and was returned to the ward after 4 days. There were repeated spinal taps and 2 additional transfusions were given. However because of redeveloping sepsis a revision of the mastoidectomy was done on April 4, 1938. A suspected petrositis was found and the dura was exposed over the middle fossa. There was a slow but good recovery and the patient was discharged on May 15, 1938. Laboratory findings were as follows: white blood count 18,600 to 26,200 to 7,600; hemoglobin 9 to 11; spinal fluid count 1,213 with high polymorphonuclear percentage to 2,016 to 45; sugar low; elevated globulin and protein; ear cultures were found positive for streptococcus; blood and spinal fluid cultures were negative. The final diagnosis revealed (1) otitis and mastoiditis; (2) acute right streptococcus; (3) serous meningitis; (4) right petrositis; and (5) bilateral bronchopneumonia.

**CASE 6** R. B. male white aged 10 years. This case was an emergency admission to Riley Hospital on February 21, 1938. The patient had headache, nausea and vomiting, pain in right ear and stiff neck. The onset occurred 2½ weeks before with sore throat followed by earache. He improved until 1 week previous to admission when the symptoms mentioned began. His past history was essentially negative. Examination on admittance showed a bulging right drum, bilateral papilledema, positive Brudzinsky, Babinski, and Kernig. A local doctor had given the patient sulfanilamide. A right mas-

toidectomy had been performed at once exposing the dura over the middle fossa; the sinus plate was soft. A good recovery followed with sulfanilamide 30 grains being administered daily for 8 days, 20 grains daily for 6 days, blood transfusion, frequent spinal fluid drainage and supportive measures. The patient was discharged on March 15, 1938, with the wound healed. Laboratory findings were as follows: blood sulfanilamide on admission 11 milligrams; white blood count 7,950 to 15,600 to 7,300; spinal fluid count 2,765 to 36; spinal fluid culture was negative; sugar was too low to read to normal; ear culture showed Gram positive bacillus. The final diagnosis revealed (1) acute right mastoiditis; (2) right otitis media; Gram positive bacillus and (3) serous meningitis.

One case with acute unilateral, hemolytic streptococcal otitis and mastoiditis and an accompanying meningitis due to an unknown Gram negative bacillus was treated successfully by mastoid surgery and sulfanilamide.

**CASE 7** No 21979 E. H. male white, aged 13 years. This patient an emergency case was admitted to Riley Hospital on February 26, 1938, with severe right earache, fever and weakness. The onset occurred 8 days before but there was no aural drainage. During the year previous he had had 3 attacks of right otitis media. Examination on admission showed a bulging right ear drum, red and tender right mastoid, positive Kernig, Babinski, and Brudzinsky, and temperature up to 104 degrees. On the following day a radical right mastoidectomy

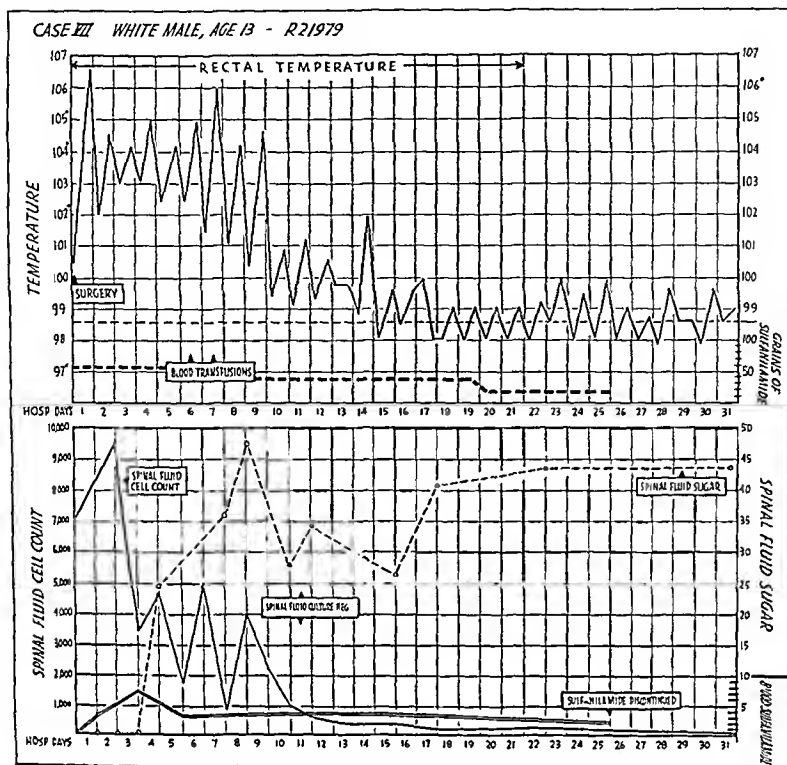


Fig 7 Case 7 Acute unilateral hemolytic streptococcal otitis and mastoiditis, occurring with a meningitis due to an unknown Gram negative bacillus

was performed when large cholesteatoma, extradural abscess, and massive granulations about the lateral sinus were found. The dura was widely exposed and the wound left open. The patient was given 60 grains of sulfanilamide daily for 7 days, then 40 grains daily for 12 days, and 20 grains daily for 7 days. A total of 1040 grains was given in all. Blood transfusions were given and frequent spinal fluid drainage was done. A good recovery followed and the patient was discharged April 13, 1938. Laboratory findings showed white blood count 13,000, 92 per cent polymorphonuclears, spinal fluid count 8,000, ear culture positive for *Streptococcus hemolyticus*, spinal fluid cultures revealed an unknown Gram negative bacillus, highest blood sulfanilamide concentration 4.4 milligrams. The final diagnosis revealed (1) mastoiditis and otitis media, acute right *Streptococcus hemolyticus*, and (2) meningitis, Gram negative bacillus.<sup>1</sup>

#### SUMMARY

Pre-sulfanilamide records of streptococcal meningitis show a depressing mortality of almost 100 per cent, whereas recent reports and our results indicate an encouraging 20 to 45 per cent.

Approximately three-fourths of all suppurative meningitis cases are caused by a pathological auditory apparatus. The importance of this pathogenetic factor cannot be overemphasized.

The etiology and pathogenesis of streptococcal otitis meningitis are discussed briefly.

Diagnosis must be prompt. One must not delay in performing a diagnostic spinal tap, carrying through any surgical procedure that is indicated, and instituting other therapeutic measures.

Treatment of streptococcal otitic meningitis consists essentially of the following factors: (1) eradication of the etiological focus by

<sup>1</sup>According to Dr. Edith Haynes, bacteriologist of Indiana University Hospitals, this organism, "a small Gram negative bacillus obtained in culture from nine specimens of spinal fluid was non-motile. It produced acid and gas from dextrose and galactose, and slowly acidified glycerol but fermented none of fourteen other carbohydrates and alcohols tested. It did not liquefy gelatin and produced no change in milk. It formed indol and reduced nitrates to nitrites. We were unable to classify it. It is possible that it was a saprophyte."

surgery which is adequately complete for each particular case, (2) drainage of the cerebrospinal fluid must be regular and frequent the simpler procedures preferable, (3) support the patient conscientiously with transfusions, intravenous fluids, physical, and mental rest, etc., (4) fight the infection with serums and above all sulfanilamide

Sulfanilamide's action may be stated as furthering bacteriostatic, bactericidal, and antitoxic action, thus reinforcing the body's own mechanisms to eradicate certain types of infection

Neoprontosil seems to be the most promising of the many derivatives of sulfanilamide

The application of sulfanilamide therapy as reported in the literature is unbelievably varied. No doubt in the final analysis, such ardent widespread usage of the drug will be unwarranted

The frequency of toxic reactions and dangerous drug idiosyncrasies in sulfanilamide therapy demands the close observation of the patient both clinically and by laboratory procedures

The 4 cases presented of otitic hemolytic streptococcal meningitis speak for themselves as to the advisability for adequate, timely surgery and for the administration of sulfanilamide. The one fatality in this group (Case 3) unquestionably had his life prolonged even though not saved by therapy. The response in Case 2 appeared almost perfect

We have every reason to believe that the 2 cases of serous meningitis reported here (Cases 5 and 6) judging from the severity of infection perhaps would not have recovered had it not been for sulfanilamide

Case 7 seems particularly interesting because of its severity and the etiological organism found on repeated spinal fluid cultures

#### CONCLUSION

After reviewing the recent literature concerning otitic meningitis, particularly the type due to the streptococcus, and the chemotherapeutic drug sulfanilamide we presented 7 cases of otitic meningitis treated during the past year with mastoid surgery as indicated and sulfanilamide. Though the outcome of these cases was not perfectly satisfactory, we

are happy to report such an unbelievable improvement in our end results

#### BIBLIOGRAPHY

1. ADAMS T L, HASSELTINE H C and HALL L R. An experimental study of behavior of sulfanilamide. *J Am M Ass* 1938 111 766-770
2. ADOLPH P E and LOCKWOOD J S. Studies in mechanism of action of sulfanilamide. sulfanilamide in treatment of experimental streptococcal meningitis. *Arch Otol* 1938 27 535-551
3. APPLEBAUM E. Sulfanilamide and related compounds in the treatment of meningitis secondary to ear and sinus infections. *Laryngoscope* 1938 48 482-495
4. ATKINSON E M. Preoperative management of acute streptococcal mastoiditis. *Arch Otol* 1938 28 10-19
5. BARNICK E G, BROWN A E and FOSTER F P. Therapeutic effectiveness and toxicity of sulfanilamide. *J Am M Ass* 1938 111 770-777
6. BERG S and HOLTZMAN M. Fatal granulocytopenia following sulfanilamide therapy. *J Am M Ass* 1938 110 370-371
7. BIGLER J A, CLIFTON W M and WEBER M. Leukocytic response to sulfanilamide therapy. *J Am M Ass* 1938 110 343-349
8. CAWTHORNE T. Streptococcal meningitis. *Lancet* Feb 5 1938 pp 304-308
9. DOMAGK G. Chemotherapy of streptococcal infections with sulfanilamide. *Deutsche med Wochenschr* 1935 31 250
10. DWYER J G. Surgical indications in suppurative meningitis. *Laryngoscope* 1938 48 461-471
11. EAGLETON W P. Intracranial conditions in relation to rhinology and otology. *Arch Otol* 1931 20 524-582
12. FINNEY J O. Severe dermatitis medicamentosa following the administration of sulfanilamide. *J Am M Ass* 1937 109 1982-1993
13. FOLSON T G. Case of streptococcus meningitis treated successfully with sulfanilamide. *West Virginia M J* Wheeling 1938 34 33-34
14. FARESEYER I and ROSENWASSEK H. The surgical treatment of (otitic) meningitis. *Laryngoscope* 1938 48 472-481
15. GEILING E M H and GANNON P R. Pathologic effects of elixir of sulfanilamide (diethylene glycol) poisoning. *Final report*. *J Am M Ass* 1938 11 949-956
16. GODWIN D E. Hemolytic strept meningitis with recovery following use of sulfanilamide, two cases. *Laryngoscope* 1938 48 59-64
17. HAGEMAN P O and BLAKE F G. Clinical experience with sulfanilamide in treatment of beta hem strept infections. *Am J M Sc* 1938 195 163-175
18. HARRIS T J. Brief (historical) review of the operative treatment of purulent meningitis. *Laryngoscope* 1938 48 458-460
19. HARVEY A M and JANEWAY C A. Development of acute hemolytic anemia. *J Am M Ass* 1937 109 12-16
20. HEMMENS F S and DACK G M. Mode of action of sulfanilamide. *J Am M Ass* 1938 110 1300-1310
21. HOYNE A L and BAILEY J H. Use of para amino-benzene sulphonamide in the treatment of strept. carriers. *Arch Pediat* 1937 54 731-733

- 22 JOHNSON, C A Brief review of the development, chemistry and clinical use of sulfanilamide *Illinois M J*, 1938, 73 235-237
- 23 KLINE, O R Meningitis of otitic origin, report of two cases *Arch Otol*, 1938, 27 739-745
- 24 KOHN, S E Acute hemolytic anemia during treatment with sulfanilamide *J Am M Ass*, 1937, 109 1005-1006
- 25 KOLMER, J A Sulfanilamide in the treatment of experimental streptococcic and pneumococcic meningitis *Arch Otol*, 1938, 27 519-534
- 26 LEWIS, R B Prontosil (sulfanilamide derivative) and sulfanilamide in treatment, eight cases (five streptococcic) *Ann Otol, Rhinol & Laryngol*, 1937, 46 1096-1111
- 27 LITVAK, A M, and KLUGHERTZ, M B Otogenic strept meningitis, review of recent literature with report of recovered case *Arch Pediat*, 1937, 54 714-725
- 28 LONG, P H, and BLISS, E A Para-amino-benzene-sulfonamide and its derivatives *J Am M Ass*, 1937, 108 32-37
- 29 *Ibid* Observations on mode of action of sulfanilamide 1937, 109 1524-1528
- 30 LOVE, J W Non-hemolytic streptococcic meningitis, case successfully treated with sulfanilamide and prontosil *J Lab & Clin Med*, 1938, 23 482-487
- 31 MARSHALL, E K, JR, CUTTING, W C, and EMERSON, K, JR Toxicity of sulfanilamide *J Am M Ass*, 1938, 110 252-257
- 32 MAXWELL, J H Management of the septic patient with otitis media *J Am M Ass*, 1938, 110 1536-1538
- 33 MOORE, R L Use of sulfanilamide in diseases of children *Internat Clin*, 1938, 3 224-234
- 34 MYERS, G B VON DER HEIDE, E C, and BALCERSKI, M Exfoliative dermatitis following sulfanilamide *J Am M Ass*, 1937, 109 1983-1984
- 35 NEAL, J B, and APPLEBAUM, E Meningitis therapy with sulfanilamide *Am J M Sc*, 1938, 195 175-182
- 36 OSGOOD, E E, and BROWNLEE, I E Culture of human marrow, mode of action of sulfanilamide *J Am M Ass*, 1938, 110 349-356
- 37 *Idem* Mode of action of sulfanilamide *J Am M Ass*, 1938, 110 1770
- 38 ROBERTS, E R Bacterial otitic meningitis A case report *Laryngoscope*, 1938, 48 409-412
- 39 SAPHIRSTEIN, H Hepatitis and toxic erythema with desquamation due to sulfanilamide *Urol & Cutan Rev*, 1938, 42 101-102
- 40 SCHWARTZ, W F, GARVIN, C F, and KOLETSKY, S Fatal granulocytopenia from sulfanilamide *J Am M Ass*, 1938, 110 368-370
- 41 SILVERTHORNE, N, and BROWN, A Treatment of meningitis due to hem strept with sulfanilamide *J. Pediat*, 1938, 12 504-506
- 42 SMITH, A B, and SCOTT, C E Streptococcal mastoiditis and meningitis following a simple tonsillectomy, with recovery *J Laryngol & Otol*, April, 1938, 53
- 43 SMITH, F W, MAYER, K F, AGERTY, H A, FOWLER, R H, and LAYTON, W C Anaerobic beta hemolytic strept meningitis of otitic origin treated with sulfanilamide and culminating in complete recovery *J Am M Ass*, 1938, 110 887-889
- 44 TAYLOR, C C, and CALVIN, C V Hemolytic strept meningitis with recovery (treated with sulfanilamide), case *J Connecticut M Sc*, 1938, 2 137
- 45 WEINBERG, M H, MELLON, R R, and SHINN, L E Two cases of strept meningitis treated successfully with sulfanilamide and prontosil *J Am M Ass*, June 5, 1938, 108
- 46 YASKIN, J C Differential diagnosis of bacterial meningitis of aural and of nasal origin *Arch Otol*, 1938, 27 444-451



# LARYNGEAL TUBERCULOSIS SURGICAL TREATMENT INCLUDING COLLAPSE THERAPY

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THE indications for surgical treatment of laryngeal tuberculosis have undergone many changes since the comparatively recent and marked advancement of thoracic surgery as applied to pulmonary tuberculosis, and accumulated experience in regard to the treatment of the larynx itself has led to a better understanding of objectives and technique.

This study was undertaken with a view to illustrate these facts by comparing a group of 136 patients treated during the 5 year period 1923 to 1928, with a group of 152 patients treated during the 5 year period, 1933 to 1938. Both groups<sup>1</sup> had local surgical treatment, chiefly galvanocauterization, but the first group had practically no collapse therapy, artificial pneumothorax alone being employed in 4.4 per cent, whereas the second group had many forms of collapse therapy applied to 49.3 per cent.

It is now a generally accepted fact that etiologically the larynx becomes involved secondary to pulmonary tuberculosis with a positive sputum, and that to obtain a negative sputum as quickly as possible is one of the main objectives in treating pulmonary tuberculosis. To this end, collapse therapy has been an important factor in improving prognosis.

Diagnosis and pathology have been well studied and presented in many excellent papers so will not be discussed. The incidence of the complication varies widely depending upon what stage of the disease has been studied. In our group of 288 patients with

laryngeal tuberculosis out of 2,179 patients admitted to the sanatorium, 12.8 per cent had this complication on admission.

It is of interest historically to recall the statement of Sir Morrell Mackenzie in 1880 "The prognosis of laryngeal tuberculosis is always extremely unfavorable and it is not certain that any cases ever recover." There was very little change in this view until Dr George B Wood, of Philadelphia, introduced treatment into this country nearly 30 years ago with the galvanocautery, and his statement, "It is undoubtedly the method par excellence for the treatment of laryngeal tuberculosis, and its use brings to the surgeon that peculiar sense of elation which he feels when, through his interference, suffering and death have been averted," marked a distinct step forward. The widespread use of the cautery, education of the public, building of sanatoria and many other measures have contributed toward an improvement of prognosis in this condition, and now with a clearer understanding of local procedures and the development of collapse therapy we are able to offer a better prognosis in this complication than ever before. In our second group of cases, improvement was obtained in over 50 per cent of the patients and I feel that in the very near future, with the added help of bronchoscopy in the treatment of pulmonary tuberculosis, a much higher percentage of improvement will be obtained. Dworetzky says "The incidence of laryngeal tuberculosis is much diminished, from 25.6 per cent to 14.6 per cent in all cases of pulmonary tuberculosis because of collapse therapy, but it is still 80 per cent in hematogenous or primary tuberculosis."

Table I illustrates the results obtained in these 2 groups. The results show a gain of only 13.2 per cent in those obtaining a negative sputum and a gain of only 8.5 per cent in improvement at discharge, as a result of the

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Presented before the Clinical Congress of the American College of Surgeons, New York, October 17-21, 1938.

<sup>1</sup> These patients were all under the care of Dr. Frank Stafford at the Blue Ridge Sanatorium & Virginia State Tuberculosis Sanatorium. The laryngeal procedures were all carried out by Dr. Habetz S. Hedges and the writer and the thoracic surgery by Dr. E. C. Drash of the University of Virginia Hospital. The writer is indebted to them for their collaboration in the preparation of this paper.

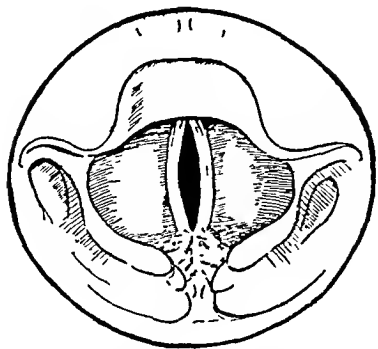


Fig 1 A diagrammatic sketch of the larynx before operation, showing the fixation of both arytenoids in the midline by a healed tuberculous cicatrix

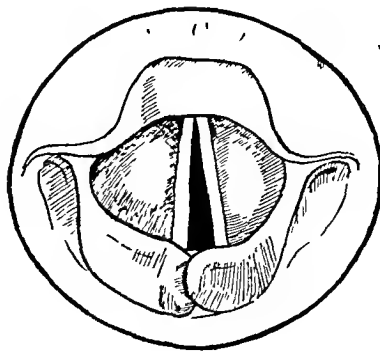


Fig 2 A diagrammatic sketch of the larynx after operation, showing the increased airway and movable arytenoids, though some distortion is present

addition of collapse therapy These figures seem somewhat lower than expected because many advanced cases were treated in the second group which were not treated in the first group All who have observed the results of collapse therapy are convinced as to its great value

Table II illustrates the types of collapse therapy employed in the treatment of these 2 groups, and is self-explanatory At present the trend seems to be away from operation on the phrenic nerve and toward pneumothorax, with and without pneumonolysis when indicated, and thoracoplasty

Outside of cauterization, no other surgical procedures were necessary except 3 tracheot-

omies, 1 plastic operation for stenosis, and a number of bronchoscopies

There has fortunately been a tremendous change in our ideas of medical treatment The literature enumerates a great many drugs and other curative procedures, which have all had their advocates in the past, while now, other than anesthetic sprays for the relief of pain, the use of chaulmoogra oil as advocated by Lukens, and a few palliative remedies, no other form of medical treatment is used Voice rest remains as one of the greatest aids in obtaining healing and should still be prescribed in all cases

The surgical treatment has likewise undergone great change In the past such pro-

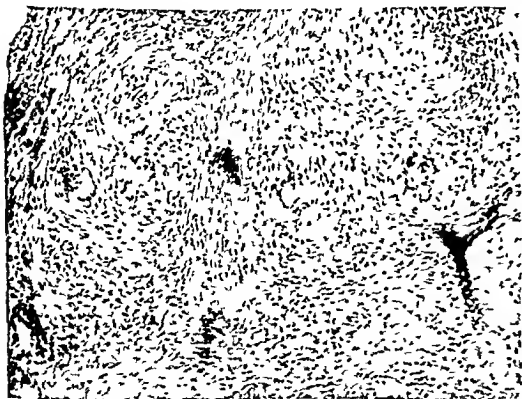


Fig 3 Photomicrograph of the tissue removed from the posterior commissure showing typical, well formed, conglomerate tubercles



Fig 4, left Anteroposterior roentgenogram, showing the rubber tube in position and the subcutaneous silver wire used in transfixion to secure immobilization

Fig 5 Lateral roentgenogram, showing the rubber tube in position and the subcutaneous silver wire used in transfixion to secure immobilization

TABLE I—COMPARATIVE ANALYSIS OF 288 PATIENTS TREATED FOR LARYNGEAL TUBERCULOSIS AT BLUE RIDGE SANATORIUM

	Gr up I 1915-1918	Group II 1919-1928
Total number of patients	1090	1133
Laryngeal tuberculosis number	136	152
Laryngeal tuberculosis per cent	12.5	13.4
Sputum positive on admission—per cent	65.6	60.1
Sputum positive on discharge—per cent	63.2	50.2
Cauterization of larynx—number	19	29
Cauterization of larynx—per cent	14.0*	19.0†
Collapse therapy number	6	75
Collapse therapy per cent	4.4	49.3
Improved on discharge per cent	44.1	52.6‡

In additional 10.5 per cent improved with artificial pneumothorax only.

\*Results show a gain of 13.2 per cent in those obtaining a negative sputum on discharge.

†11.0 per cent improved when all types of collapse therapy were used.

‡There was a gain of 8.5 per cent in improvement at discharge as the result of the addition of collapse therapy.

cedures as thyrotomy, curettage of ulcers, and even laryngectomy were advised in acute and active cases. None of these would find a sponsor today.

#### SURGICAL PROCEDURES

Among the surgical procedures used today, we find the following:

1 Galvanocauterization is the most valuable. The indications and technique have been well described by George B. Wood and Joseph B. Greene in various publications, and I need only add that when properly used the results are most gratifying both to the patient and to the surgeon. However, one must remember that too deep and extensive cauterization about the cords and arytenoids may produce stenosis either through inflammatory swelling or by subsequent cicatrization. The results of cauterization in suitable cases by following the sedimentation rate have been well shown by Greene.

2 The local removal by direct laryngoscopy of tuberculous tumors may be necessary at times and differs in no way from other surgical procedures done by direct laryngoscopy except that light cauterization of the base of the tumor seems wise, in order to prevent a local spread of the disease through the traumatized tissue and lymphatics. Radiation therapy by the roentgen ray should be helpful in some cases of this nature.

TABLE II—COLLAPSE THERAPY

	Gr up I Number	Gr up II Number
Pneumothorax		
Without pneumonolysis	6	35
With pneumonolysis	0	14
Phrenics		
Temporary	0	13
Permanent	0	9
Thoracoplasties		
Partial	0	1
Complete	0	1
Totals	6	15

3 Biopsy will be necessary in some instances in which there is a question of syphilis or carcinoma. Cases of this nature have been reported by Gabriel Tucher and others. The writer recalls a case of advanced pulmonary tuberculosis in which biopsy showed a tuberculous ulceration and carcinoma in the same section. This patient likewise had a strongly positive Wassermann, but syphilis was apparently not involved in the laryngeal lesion. A carefully done biopsy should not be contraindicated, but light cauterization of the base would again seem to be advisable.

4 Incision and drainage of abscesses either within the larynx or subcutaneously from chondritis of the laryngeal cartilage should be carried out when necessary in the same manner as abscesses from other causes are handled.

5 The removal of the epiglottis has been done many times when disease was far advanced and painful and has given satisfactory results either by punch forceps with cauterization of the base or by snare and the coagulating current.

6 A block of the internal branch of the superior laryngeal nerve has been repeatedly done for the relief of pain, but since the use of the cauterium and collapse therapy we have not found it to be necessary in a single case reported in this series. An occasional temporary block will at times be advisable, but one should never advise resection of the nerve itself.

7 Tracheotomy will be necessary for laryngeal dyspnea in rare instances but never with the idea of putting a larynx at rest in order to promote healing, for neither objective would be obtained. The indications for tracheotomy are still those of laryngeal ob-

struction, and in tuberculosis, we find that ulceration and edema, caused either by disease or too extensive cauterization, will necessitate tracheotomy in acute cases, and for tuberculomas, cicatrization, and paralysis of both cords in chronic cases.

The technique of the operation is the same as for any tracheotomy, except that a two stage operation is preferable. As always, a tracheotomy should be anticipated and done as an elective procedure in an orderly manner under aseptic technique. It has been our custom to dissect carefully down to the trachea and expose it completely at the site for the introduction of the tube, then pack the wound open with gauze and partially close the skin. From 3 to 5 days later, the wound is re-opened, the gauze removed, and the tracheal tube inserted without difficulty. By following this procedure, the tissues are protected by granulations, and we are much less likely to get a secondary infection about the wound and skin. This method has been employed in 3 cases of laryngeal tuberculosis and in many other cases of lung suppuration without ever having an infected wound. Meyerson reported 9 tracheotomies, among which the indications were tuberculoma, necrosis of the thyroid cartilage, ulcer and infiltration of the glottis, fixation of both vocal cords by paralysis, fixation of both cords by scar tissue, and fixation by ulceration and infiltration.

8 Cicatricial stenosis of the larynx can be caused by healing of tuberculous ulcers in the interarytenoid space and surrounding region; too active cauterization in this region may also tend to a similar condition. This unfortunate condition is seen at times with an arrested pulmonary infection and often condemns the patient to a life with a tracheal tube, unless some form of plastic operation can be done in order to restore the airway. Since most of the tuberculous ulcerations are seen in this locality, it is not surprising that this problem is met at times.

In the consideration of this problem, one must be sure that the stenosis is due to cicatrization and fixation of the arytenoids and not due to paralysis of the vocal cords. In either event, a tracheotomy should be done, and if we have an arrested pulmonary lesion,

a plastic repair after the method of Schmiegelow can be done, or, in the latter condition, we may gain an adequate airway after the method of Looper by the interposition of the end of the hyoid bone between the edges of the divided thyroid cartilage.

When there is scar in the posterior commissure and fixation of both arytenoids in the mid line, dilatation under direct laryngoscopy is not advisable because of the repeated trauma in a healed tuberculous lesion; but both airway and voice can be restored by thyrotomy, the careful removal of scar tissue by cup forceps, and the introduction of a rubber tube after the method advocated by Schmiegelow.

This procedure has been done repeatedly with uniformly good results for laryngeal stenosis from other causes, but because of the nature of this lesion, it has not been advocated. However, we carried it out on 1 patient with good results, and if we have an arrested pulmonary lesion and a healed cicatrix in the posterior commissure with fixation of both arytenoids in the mid line, I see no reason why it should not be applied to all similar cases.

This operation is readily carried out under local and light basal avertin anesthesia; the tube is well tolerated, and since the ends of the fixation silver wire are buried under the skin, there is very little pain. However, a feeding tube will be necessary for a few days in order to maintain sufficient nutrition, and the tracheotomy tube should be left in for several weeks until we are sure that an adequate airway has been obtained.

9. Bronchoscopy is rapidly being recognized as a valuable adjunct in the treatment of pulmonary tuberculosis, especially when there is involvement of the bronchi and trachea, also for diagnosis in questionable cases, and to furnish valuable information to the thoracic surgeon.

Kernan has reported many cases in which bronchoscopy was useful in treatment and, in summing up, says, "We have the treatment of ulcers by coagulation, silver nitrate, and the quartz rod, of strictures by stretching with copper ionization; of tubercular tumors by removal with forceps or coagulation, of ob-

struction, either by a mass of mucus or a mass of cheesy material in cavities or by a mass of cheesy material in ruptured glands, by aspiration, of secondary abscess or of bronchiectasis beyond strictures, by aspiration."

Bronchoscopy, by its value in treating pulmonary tuberculosis indirectly, may help the laryngeal lesion, and, I believe, it will occupy an increasingly important place, as time goes on, in the general treatment of tuberculosis. An interesting paper on the pathogenesis of tuberculous tracheobronchitis was presented by Bugher, Littig, and Culp.

10. Collapse therapy in some manner was carried out in approximately 50 per cent of all patients during the past 5 years. Out of a total of 1,139 admissions to the sanatorium, 568 had collapse therapy, against 48 out of 1,090 patients admitted during the 5 year period 1923 to 1928. Of course pneumothorax without pneumonolysis represents the greatest number, 331 patients having this form of collapse. With pneumonolysis the number was 82, phrenics temporary were 84, phrenics permanent, 51, thoracoplastics partial, 15, and thoracoplastics complete, 5.

Because of the many facts enumerated, we have felt that it was time to review the question of laryngeal tuberculosis and to evaluate the various surgical procedures used today in treatment, giving the results obtained in a

closely controlled group of patients along with the conclusions we have reached by experience, and to point the way for future guidance, for although we may feel some degree of pride in reporting over 50 per cent improvement, as compared to Dr Mackenzie's gloomy statement of nearly 60 years ago we must remember that there is still a long way to go before we may allow ourselves more than a small degree of pride.

#### BIBLIOGRAPHY

1. BUGHER, LITIG, and CULP. Tuberculous tracheobronchitis its pathogenesis. *Ann J M S.* 1929 193 515.
2. DWORETZKY, J. P. Modern concepts of laryngeal tuberculosis. *Ann Otol, Rhinol & Laryngol* 1938 47 481-501.
3. CREPPE, J. B. Prognosis in laryngeal tuberculosis. *Arch Otol* 1937 26 18-23.
4. KERNIV, J. D. Tuberculosis of the trachea and bronchi. *Ann Otol, Rhinol & Laryngol* 1938 47 106-116.
5. LOOPER, E. A. Use of the hyoid bone as a graft in laryngeal stenosis. *Arch Otol* 1938, 28 106-111.
6. LUKENS, R. M. Section on Medical Treatment of Laryngeal Tuberculosis. The Nose, Throat and Ear and Their Diseases, by Jackson and Coates. Philadelphia W. B. Saunders Co. 1919.
7. MEYERSON, M. C. Tuberculosis of larynx requires tracheotomy. *Arch Otol* 1936 23 1-17.
8. SCHMIEGROW, F. The surgical treatment of cicatricial stenosis of the larynx. *J Otol. & Laryngol* London 1938 53 1-15.
9. WOOD, G. B. Section on Laryngeal Tuberculosis. The Nose, Throat and Ear and Their Diseases by Jackson and Coates. Philadelphia W. B. Saunders Co. 1919.

# A STUDY OF MEDICAL AND SURGICAL AIDS TO HEARING

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MUCH in the general field of otolaryngology has reached a certain stage in finality. The management of acute and chronic sinusitis, allergy, focal control in the Waldeyer ring, peroral endoscopy, mastoid surgery, and plastic reconstruction, would seem to have been largely accomplished; and the student, zealous for pioneer work, simply delves farther back in the embryological field or forges a little ahead with greater care and precision in already well beaten paths.

In the department of otology, however, after rather conclusive investigations in petrositis, otitic meningitis, and labyrinthine vertigo, there has occurred almost a renaissance in the medical and surgical attention to progressive deafness, a transition from the ineffective routine tubal politzerization to a combined biochemical, mechanical, and surgical attack upon this great problem. This strikes a responsive note in a large group of people, who venture the thought, "Am I growing deaf, and what am I going to do about it?"

The purpose of this paper is to group, analyze, and discuss informatively the whole problem of deafness, including its recent rather dramatic surgical episodes. Mechanical appliances, so adequately investigated by Fowler, Newhart, and the Council on Physical Therapy of the American Medical Association, need be discussed only in reference to the patient's psychological attitude. These fundamental topics are suggested for consideration (1) medical management in deafness, (2) readjustment in upper respiratory tract from physiological and focal standpoints, (3) deafness and chronic otological infection, and (4) otosclerosis and fistulization surgery.

## MEDICAL MANAGEMENT OF DEAFNESS

It is the intention to discuss deafness upon a broad basis, accepting research conclusions on acoustics, the mechanical variations in

bone conduction, histological changes in the organ of Corti, etc., without sharing in the intricate research which has formed them. Deafness for the purposes of this heading refers chiefly to the popular form of progressive deafness, of the so called dry or catarrhal type, more often combining conductive and perceptive elements. One is accustomed, somewhat inaccurately, to associate conductive disturbance with the middle ear, which includes the eustachian tube, tympanic cavity, and mastoid area, and also to associate perceptive loss with the cochlea and its neural connections with the brain centers. Emerson, however, in 1924 left a lasting impression of his conception of the interrelation of these elements, in a paper under the caption, "Is Chronic Progressive Deafness a Rhinologic or Otologic Factor?"

The examination of a patient with a view to medical readjustment should be more painstaking and with a far broader scope than an ordinary routine, upper respiratory review. Accurate tests for degree and type of deafness should be carefully recorded, and the last word on familial information and the patient's environment obtained.

This basic study must include various factors in nerve damage, as suggested by Hughson, acute infections with neural influence, drug poisoning, congenital influence, nutritional, vitamin and dietary imbalance, occupational hazards, endocrinopathies, hypothyroidism and dyspituitarism, and central nervous system lesions, producing cochlear degeneration by cutting off blood supply rather than affecting the auditory nerve, which is not supposedly susceptible to the *Spirocheta pallida*. Dean and his associates have published a convincing thesis upon allergic diseases of the ear with its special relation to labyrinthine disorder.

Preliminary work in deafness prevention has been done by a group of investigators, notably Covell in San Francisco, Dorothy Wolfe in St. Louis, Taylor in Jacksonville,

and Mosher in Boston, with their masterly demonstration of the prenatal influence of drugs on the neuro-otological perceptive apparatus. *This fits in with the preventive and eugenic programs of child hygiene.*

The psychological factor in deafness is of great medical importance. In a recent communication from Friesner, quoted by permission, occurs the following:

"If one reasons about hearing, one rapidly comes to the conclusion that hearing is an extremely complex mechanism. It is a process that is part physical, part psychical, and curiously enough is influenced by factors both physical and psychic that have no direct relationship to hearing, depend not only upon the reception of nerve stimuli aroused by vibrations in the end organ, but also upon the facile interpretation of these stimuli. Any factor that upsets the mental or physical well being of a patient with a hearing defect disturbs hearing even though the ear mechanism is unaffected and remains as before. The psychic element in deafness is a tremendously important one. Unhappiness for a day may seriously disturb the hearing and yet on the following day the hearing may have returned to normal obviously this cannot be accounted for by any change in the peripheral organ. Deafened patients who hear with a smile do much better than others with similar hearing defects who constantly grieve."

The nutritional index in deafened patients has claimed increased attention in recent years. Added stimulus has come from the impressive contributions upon vitamin and nutritional deficiencies so carefully presented by Selfridge in California. It will be seen what careful physiological and biochemical study of each patient must be made, including careful laboratory analysis of vitamin deficiency from A to G, phosphorus, cholesterol, and serum proteid estimation, x-ray studies of the long bones, and basal metabolism with routine blood and urine analysis.

It is but fair also to refer to the patient work of Jarvis and other nutritional groups in studying the ordinary dietary imbalance. A recent communication from him states:

A continued study of the body process of cell oxidation has revealed that when a block in cell oxidation is present clinical conditions appear in epiblastic tissues of which the ear is one. Applying the theory of a block in cell oxidation I find that children brought in by mothers with the statement "my child is asking over and the school teacher tells me he does not hear well at school, are easily

straightened out. They are asked to exchange wheat foods which are difficult to oxidize for rye bread and corn meal foods. They are asked to exchange white sugar for a monosaccharide represented by honey. They are asked to exchange milk, as a beverage for grape juice and water, equal parts."

Cod liver oil containing organic iodine and arsenic, two good oxidizing minerals, is advised.

Crowe, with a certain dread finality, considers high tone deafness present in the fourth decade of each individual's life, and that it progresses regularly through each succeeding decade. Selfridge, however, believes that optimum nutrition can delay progress of eighth nerve degeneration when recognized early and permanently corrected, and that it is possible after the fifth decade to ameliorate deafness if the tone range from 240 to 4096 double vibrations is not hopelessly damaged. Here the remarkable result of Furstenberg's salt free diet and ammonium chloride administration in Meniere's complex should also be mentioned.

With an enthusiastic assistant, Dr. Silcox, an analysis has been made of the results of routine nutritional and vitamin care in a series of over 100 office patients in whom the effect of vitamin B complex was carefully studied. It seems fair to assume that the changes in audiometric record as reported indicate the effects of the administration of tablets containing vitamin B 80 and vitamin G 25 Sherman units, combined with iron and administered 3 times daily over a measured period. There was almost immediate response to the initial administration with sometimes dramatic improvement. However, after varying periods of time, the hearing dropped back in some cases, suggesting that the early administration was in the nature of a neurophysiological stimulus which needed further nutritional support.

#### READJUSTMENT OF UPPER RESPIRATORY TRACT FROM PHYSIOLOGICAL AND FOCAL STAND-POINT

That known focal infections in the upper respiratory tract, as well as gastro intestinal, genito urinary and the general lymphoid distribution, may profoundly affect both per

ceptive and conductive integrity in the acoustic tract is indisputable. In the upper respiratory tract this concerns sinuses, teeth, the entire Waldeyer tract, pyriform fossæ, and the middle and external ear.

Ever since the expressed views of Logan Turner, Leland, Emerson, and others, confusion of opinion has persisted as to the exact contribution of lymphoid pathology to progressive deafness. The explanation of frequent disappointment in the relief of routine tonsillectomy and adenoidectomy rests in the compensatory hypertrophy of this pharyngeal tissue, poorly covered and easily re-infected from postnasal secretions sweeping down over them in acute or chronic sinus infection. Good tonsil surgery will include the removal of not only these masses but also of the small masses of lymphoid tissue at the base of the tonsillar fossa. A small triangular punch is recommended for this purpose. It is surprising how inconsequential the evidence of "punch" appears on the pharyngeal wall 48 hours afterward, and how little additional discomfort is given the patient. If these compensatory masses need only slight attention, a light coagulation diathermy while producing temporary discomfort will soon remove the trouble.

Schenck has presented a careful paper on chronic infections in the pharynx with demonstration of pathological slides in cases of articular pains, choreiform manifestations, cervical adenopathy, myalgia and nephrosis, which certainly suggest toxic relation to our progressive deafness.

In addition to the relief of focal toxemia, there would seem to be an important field in the study of physiological readjustment in this tract. For example, the closely approximated septum and middle turbinate in the presence of marked septal deviation, in its disturbance of respiratory aeration and drainage, its possible influence in the distortion of tissue arrangement around the eustachian tube mouth, hyperplasia of turbinate structures covering sinus areas on the concave side of the nasal septum, vasomotor imbalance in the upper nasal chambers, secondary influence of hypertrophy and fibrosis upon the mucous membranes of the sinus cavities, pharyngeal wall, and even eustachian tube, are all matters

of as much physiological importance as the developmental abnormalities attendant upon the high-arched palate of the mouth breather.

The tradition has grown to condemn tonsil and pharyngeal lymphoid tissue removal, as well as sinus and septal surgery in advancing deafness, with the same finality as the useless routine of tubal politizerization. The same obsession against the readjustment of the nasal septum before 16 or 17 years of age disregarded the serious consequences of nasal block in early childhood.

#### DEAFNESS AND OTOLOGICAL INFECTION

There are many variations under the title of otological infection which deeply concerns the function of hearing. An insidious type of infection is the almost quiescent chronicity, with intermittent drainage, in a middle ear filled with sclerotic tissue. Perhaps among the most important are sequelæ of faulty mastoid and middle ear surgery when adequate technique would have conserved hearing. Mosher, Friesner, Page, Boies, Smith, and others have rendered invaluable service in their teaching of complete surgery. This otological housecleaning in chronic infection deserves just this emphasis for both its reparative and preventive function.

Mastoid procedures by the external postauricular route have been related adequately elsewhere. Chronic middle ear suspicion in suitable cases invites the endaural approach. Preliminary steps include the careful cleansing with iodine and alcohol of the canal approach. Evidences of atresia, small, deep exostoses, eczematous crusts and granulomas must be cared for first, and, as these are chronic cases, there is no need for premature haste. Measures of option are then the complete or total ossiculectomy, some form of modified attic drainage in which free drainage from the antrum down through the posterior half of the tympanic area is secured, and the Tobey procedure of combining ossiculectomy and lateral mastoid drainage.

Lessons from the fistulization technique and from Smith's recent modification of mastoid procedure, suggest the combination of attic and antral drainage with removal of the incus or the head of the malleus in cases in which



resistant attic infection complicates that of the middle ear. This procedure, preferably by the endaural route, opens the mastoid antrum at a point two thirds of the way down from the spine of Henle to the posterior margin of the tympanic ring. The antrum and diseased adjacent mastoid cells are carefully cleared away, the external semicircular canal and then the incus are exposed and may be removed. The conventional radical mastoidectomy does lower hearing, does not overcome all subsequent drainage, and because of granulation tissue and fibrosis, or actual labyrinthine damage imperils the function of the internal ear. The procedure described should preserve the hearing by protecting the normal aditus, producing a flexible ossicular chain and maintaining a normal posterior tympanic wall.

The character of the tympanic perforations, central lateral wall, and attic must influence to a large extent the choice of procedure. The central tends toward self limitation, the lateral wall especially in the neighborhood of the eustachian tube, permits constant re-infection and the attic perforation, either anterior or posterior contributes toward the walling off of cholesteatomatous material, which in the attic antral area produces a tumor like pressure often with grave osseous wall disturbance. Single and multiple perforations invite ingenuity in the obtaining of coalescent and adequate drainage.

#### OTO-SCLEROSIS AND FISTULIZATION SURGERY

This combined heading heralds the most remarkable surgery of the ear today. Far developed by Holmgren in Sweden and Sourdis in France the recent demonstrations of the new Lempert approach and technique have brought the problem close to able surgeons in America. The purpose of this paper is to crystallize basic facts relative to a successful fistulization. The important question at issue is the permanent maintenance of mobility in the labyrinthine fluid, in other words the prevention of the closure of the fistula by osteogenetic change.

Historically, according to Holmgren fistulization dates from 1876, when Kessel removed the stapes in order to replace the footplate

with a movable scar membrane. Passow experienced the same results in 1897 by trephining the promontory. A group of famous otologists, including Politzer, Moure Siebenmann, Botey and Denker, were found to be in opposition to the stapes extraction.

Barany in 1910 opened a fistula in the posterior vertical canal. In 1913 Jenks opened the horizontal semicircular canal twice, covering one with a Thiersch and another with a metal flap, but returning deafness discouraged him. Holmgren began using magnifying glasses in 1920, making a fistula in the promontory, but this, too closed. In 1922 he had better success with a macro-perosteal flap from the ampulla. At the time of his report in 1937, he had done about 34 human cases in 15 years, and of late was using gold leaf prosthesis covered with fat. Upon the principle of decompression of the labyrinth, he made fistulas to horizontal and posterior semicircular canals and sometimes even to the anterior vertical. Immediately following operation, some vertigo appeared which disappeared within a month. Tinnitus disappeared during the operation, but in failure of maintenance of hearing turned its own return with that of healing in the general operative field.

Sourdis, in 1937, presented his new fistulization technique for the surgical treatment of otosclerosis. In his discussion he first mentions 2 other schools of surgical attention: (1) the Wittmaack Heynainz Rollin method designed to combat the perilymphatic venous stasis, he suggests calling it the 'elevation of the supra tympani dura mater', (2) the Alonso Chianino method of removing one parathyroid or suppressing its function by ligation of its principal vessels.

The operation of Sourdis was originally in 3 stages and by postauricular incision. The first 2 stages were devoted to mastoid excision, exposure of the external semicircular canal and preparation of a reconstructed tympanic system. His operation termed "tympano labyrinthopathy" consisted in joining the covering membranes of the labyrinthine fistula with the superior border of the tympanic membrane whose excursions have been increased by the removal of the

malleus head The incus is preserved in its place, and, according to Holmgren, acts as a mobile prop and permits displacement of the whole system Sourdille's operation, according to his report, has been performed on 109 patients, with 10 times or more previous hearing distance in 40 per cent, 5 to 10 times previous hearing distance in 14 per cent, mediocre results of 2 to 5 times previous hearing distance in 20 per cent and no fatalities—in other words, 54 per cent of definite improvement

Lempert of New York has developed the one stage procedure via the endaural approach, and in July, 1938, reported operations on 23 patients, 4 of whom had a bad background Nineteen showed good practical improvement, but the canal remained open in 22 of the 23 cases Since this report, he has added 36 fistulization operations, making a total of 59 In all but 9 of these cases the fistulas have remained open In a recent visit to New York to observe his technique, we personally reviewed 20 of these cases Of these 20 operated-upon patients, after a varying period of from 3 weeks to 9 months, all had well healed flaps and 19 of the 20 a good fistula reaction The one weak test followed an otitis media complication Of course these were favorable cases, selected for our review All the patients appeared optimistic and some showed the exhilaration euphoria to which ear patients are prone At the time of our review there was insufficient time to test the improvement of each patient with the audiometer, but there were unquestionably results sufficiently favorable, to be a source of great stimulation for future work

An estimated analysis of endaural fistulization in this country, by other operators than Lempert, gives a total of 30 cases, 8 of which thus far give promise of favorable results, 6 apparently had labyrinthine complications, and the remainder showed doubtful gain over the pre-operative status, but there were no fatalities

While somewhat difficult to place chronologically, mention must be made of a patient reported in 1935 by J S Fraser of Edinburgh, upon whom he had done a radical mastoid and fistulization 17 years previously The bony

cap of the lateral canal was removed and a graft applied with a favorable hearing result and a positive fistula test after 17 years

These results have been presented to indicate that from a surgical standpoint this operation reasonably points to success While somewhat tedious, two facts are definite, as stated by Canfield in his discussion at the American Otological Society's meeting, first, that the fistula increases the air-borne sound, and second, that human beings do not incur undue surgical risk and are only moderately inconvenienced by the operation

The operation presents to an observer about 5 important steps one, the exposure through a mastoidectomy of the horizontal semicircular canal, two, the skeletonizing of the anterior and posterior epitympanic areas for liberating the tympanic sulcus, three, the isolation and removal of the malleus head, four, the careful burring into the semicircular canal, a saucer or trough-like excavation, to relieve the endosteal retention without injuring the membranous canal, and five, the application of a careful flap, constructed from fibrous scar tissue, mucoperiosteum, tympanomeatal or Shrapnell's membrane, to close the fistula adequately The cases selected should be definitely otosclerotic cases or combined progressive deafness closely simulating them, without mastoid or posttympanic infection

Otosclerosis, according to Cahill, clinically presents an ankylosis of the stapes, progressive deafness usually bilateral, and a severe tinnitus, yet with normal drum membranes and patent eustachian tubes. It must satisfy the Bezold triad of lengthened bone conduction, a negative Rinne test, and elevation of the lower tone limits, and there should probably accompany it the paracusis of Willis, meaning the ability to hear conversation better in the presence of a noise, and the pinkish tinge over the promontory representing the active, underlying osteoporosis Its etiology is variously assigned to familial transmission, toxemia, infection, adolescence, or the pregnancy complex

It is appropriate to present the endaural work of Hughson in closure of the round window for the aid of hearing in progressive deafness His work has always been so careful

and scientific that it deserves most thoughtful consideration. In his opinion, "the demonstrated extent of nerve involvement and its probable cause are alone the standards where by operability can be determined. Routine loudness balances, repeated bone conduction audiograms with appropriate masking, supplemented by fatigue tests, give accurate information as to the amount of the organ of Corti and nerve remaining." When this has been established, he feels that fixation of the round window by graft increases the intensity of tone stimulus. He has presented the results of 25 operations for blocking the round window niche with a tissue graft. No further impairment occurred in any and a maximum of 20 per cent improvement was obtained in 1 patient, with an average increase of 10 decibels in all critical frequencies. This improvement occurs later than in the fistulization procedure. Wishart, in his admirable discussion, has commended Dr. Hughson's painstaking and accurate work but questions the ultimate fate and value of the graft.

In conclusion we have tried to give parallel incidents in the nutritional, the upper respiratory, elimination of infection, fistulization, and round window graft aids to hearing. There is apparently not too wide a difference in the measured results of each though there is a wide variance in the dramatic finesse involved. It may be that composite decision will prefer ultimately to accept the value of the greatly improved mechanical devices and educate the sensitive deaf to accept a hearing apparatus as they would a toupee or false teeth. Nevertheless it is hoped that this discussion will increase in the surgeon's faith in vitamin and nutritional possibilities, hope for the slowly demonstrated improvement in upper respiratory correction and charity toward the pitfalls and by-passes of labyrinthine fistulization.

#### REFERENCES

- CARILL, H. P. Otitis Media, The Nose, Throat and Ear and Their Diseases. Jackson and Coxes Philadelphia W. B. Saunders Co. 1919, p. 503.
- COVELL, W. P. A cytologic study of the effects of drugs on the cochlea. Arch Otol 1936 23 633.
- DEAN, L. W., AGAR, J. S. and LENTOV, L. D. Allergic diseases of the ear. Laryngoscope 1931, 41, 67.
- DICKIE, J. F. M. Chronic progressive deafness, etc. Arch Otol 1936 23 694.
- Edelson. Vitamin C and complement. J Am M Ass June 25 1937 110 2157.
- FRANKSON, F. I. Is chronic progressive deafness a rhinologic or otologic factor? Ann Otol Rhinol & Laryngol 1924 33 865.
- FOWLER, E. P. Report of The American Otological Society Representatives on Committee for Hearing Aids and Audiometers of Council on Physical Therapy of Am M Ass. Laryngoscope July 1936 47.
- Idem. The factual background for the treatment of progressive deafness from otosclerosis. Laryngoscope, 1937 47 847.
- FRASER, J. B. Bilateral otosclerosis. Radical mastoid operation on worse hearing ear. c c f Laryngol & Otol 1935 50 700.
- FRISVOLD, I. and DAUSS, J. G. Critique of the present treatment of deafness due to lesions in the conduction mechanism. Arch Otol 1931 26 21.
- HOLMGREN, G. The surgery of otosclerosis. Ann Otol Rhinol & Laryngol 1937 46 311.
- HUGHSON, W. The inner ear from an experimental and clinical standpoint. Ann Otol Rhinol & Laryngol 1936 47 68.
- Idem. Rationale technique etc. with grafts in the round window. Laryngoscope 1938 48 533.
- MOSELEY, H. P. Does animal experimentation show similar changes in the ear of mother and fetus after ingestion of quinine by the mother? Laryngoscope 1938 48 361.
- LEUTZT, J. Improvement of hearing in cases of otosclerosis. Arch Otol 1938 48 41.
- NEHMER, H. and HARTZ, H. E. Performance characteristics of electrical hearing aids for the deaf. Arch Otol 1936 23 617.
- PERKINS, O. C. Dietary deficiencies as the etiologic factors in certain neurological syndromes. J Nerv & Ment Dis 1936 83 505.
- SCHEENK, H. P. Chronic infections in the pharynx. Tr Am Laryngol Ass 1936, p. 164.
- SELWIDGE, GRANT. Chronic progressive deafness from a nutritional standpoint. A preliminary report. Ann Otol Rhinol & Laryngol 1937 46 81.
- Idem. Can certain diseases of ear, nose and throat especially degeneration of eighth nerve be classed as deficiency diseases? Laryngoscope 1936 46 85.
- Idem. Eighth nerve high tone deafness from a nutritional standpoint. Ann Otol Rhinol & Laryngol 1937, 46 91.
- SHAMBAUGH, G. E. Jr. Chronic progressive deafness, including otosclerosis and diseases of the inner ear. Arch Otol 1937 26 583.
- SMITH, J. MORSE. A. Surgical technique for the conservation of the hearing in chronic mastoiditis. Laryngoscope July 1938.
- SOURDILLE, M. New technique in surgical treatment of severe and progressive deafness from otosclerosis. Laryngoscope 1937 47 853-873.
- Idem. Present position of surgical treatment of otosclerosis. J Laryngol & Otol 1938 48 39-43.
- TAYLOR, H. W. Deafness from drugs and chemical poisons. Laryngoscope 1937 47 603.
- WACKER, H. Surgery of the nasopharynx in chronic progressive deafness. Laryngoscope 1938 48 357.

# THE PHYLOGENETIC DEVELOPMENT OF THE EAR

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**K**NOWLEDGE of the phylogeny of the human ear involves a study of the organs of hearing of nearly related contemporary species as well as of species as remote in relationship as their occurrence in time

The fact that in many insects there are highly specialized organs for the production of sounds indicates that insects possess also the function of hearing. The sound-producing organs of grasshoppers and crickets probably produced the first not merely accidental and functionless sound in the history of life. It serves principally to bring the sexes together. The sound is produced by the friction of a file on the under side of the left forewing over a ridge on the upper side of the right

Auditory organs in their simplest form consist of fine rods suspended between two points of the integument and connected with nerve fibers. This morphological unit may or may not be associated with a tympanum. The peg-like rod, with nerve attached, is known as the scolopophore. The wall of the scolopophore is composed at either end of 7 ribs, each of which is divided in the central portion, making 14 ribs. The entire scolopophore is bathed in fluid and is free to vibrate.

In other species, more elaborate organs are developed. In grasshoppers, highly specialized ears are situated, one on each side of the first abdominal segment. The tympanum is conspicuous as a thinned portion of the body wall. Closely applied to the inner surface of each tympanum is a ganglion known as Muller's organ. Intimately associated with Muller's organ are two horny processes (bone conduction) and a pear-shaped vesicle. Near the margin of the tympanum there is a spiracle, or the Eustachian analogue, which admits air to a space inside the tympanum, or the tympanic chamber. As the nerve endings in Muller's organ are attached to the tym-

panum, it is classed as a chordontal organ of the integumental type. The other type of chordontal organ ends free in the body cavity.

In the long-horned grasshoppers, known as locusts or katydids, and in the crickets there is a pair of tympana near the proximal end of the tibia of each foreleg. Some forms present an external canal. Within the legs bearing these tympana there are chordontal organs. There is also a trachea in each leg of a locust. The tracheas in the forelegs are remarkable for their great size and for the division into two branches. These two branches reunite beyond the end of the chordontal organs.

There are really 3 distinct types of chordontal organs, or cochleæ, in each foreleg of the locust. In the supratympanal form there is a ganglion composed of nerve endings which are scolopophores of the integumental type. Immediately below this is the intermediate organ in which the scolopophores are of the subintegumental type. Third, there is Siebold's organ, or crista acoustica, on the outer surface of the large trachea. This consists of a series of scolopophores which diminish in length toward the distal end of the organ. It forms a ridge on the trachea, therefore the name, "crista acoustica."

The hearing mechanism of the mosquito is connected with the antennae. At the bottom of the antennae is an enlargement, the scape, in which the muscles lie. Just above the scape is a greater enlargement, the pedicle holding Johnston's organ or the auditory apparatus, which differs in the two sexes, being more highly specialized in the male. Briefly, this organ consists of whorls of scolopophores, with their attached nerves. Experimentally it has been shown that the different whorls, which decrease in length on successive segments, are caused to vibrate by different notes (Mayer, 1874). It was formerly believed that the great specialization of Johnston's organ in male mosquitoes enabled the males to hear the songs of the females. But it has been

From the Departments of Ear, Nose, and Throat of Harper and Herman Kiefer Hospitals.

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and scientific that it deserves most thoughtful consideration. In his opinion, "the demonstrated extent of nerve involvement and its probable cause are alone the standards where by operability can be determined. Routine loudness balances, repeated bone conduction audiograms with appropriate masking, supplemented by fatigue tests give accurate information as to the amount of the organ of Corti and nerve remaining." When this has been established, he feels that fixation of the round window by graft increases the intensity of tone stimulus. He has presented the results of 25 operations for blocking the round window niche with a tissue graft. No further impairment occurred in any and a maximum of 20 per cent improvement was obtained in 1 patient, with an average increase of 10 decibels in all critical frequencies. This improvement occurs later than in the fistulization procedure. Wishart, in his admirable discussion, has commended Dr. Hughson's painstaking and accurate work but questions the ultimate fate and value of the graft.

In conclusion we have tried to give parallel incidents in the nutritional, the upper respiratory, elimination of infection, fistulization, and round window graft aids to hearing. There is apparently not too wide a difference in the measured results of each, though there is a wide variance in the dramatic finesse involved. It may be that composite decision will prefer ultimately to accept the value of the greatly improved mechanical devices and educate the sensitive deaf to accept a hearing apparatus as they would a toupee or false teeth. Nevertheless, it is hoped that this discussion will increase in the surgeon's faith in vitamin and nutritional possibilities, hope for the slowly demonstrated improvement in upper respiratory correction, and charity toward the pitfalls and by-passes of labyrinthine fistulization.

## REFERENCES

- CARILL, H. P. Otitis media. The Nose, Throat and Ear and Their Diseases. Jackson and Coates Philadelphia W. B. Saunders Co. 1949 p. 502.
- COVELL, W. I. A cytologic study of the effects of drugs on the cochlea. Arch. Otol. 1936 21: 623.
- DEAN, L. W., AGAR, J. S. and LINTON, L. D. Allergic diseases of the ear. Laryngoscope 1937 47: 70.
- DICKIE, J. K. M. Chronic progressive deafness, etc. Arch. Otol. 1936 23: 694.
- Editorial. Vitamin C and complement. J. Am. M. Ass. June 25, 1935, 110: 2157.
- FRERSON, F. I. Is chronic progressive deafness a rhinologic or otologic factor? Ann. Otol. Rhinol. & Laryngol. 1924 33: 805.
- FOWLER, F. P. Report of The American Otological Society Representatives on Committee for Hearing Aids and Audiometers of Council on Physical Therapy of Am. M. Ass. Laryngoscope July 29: 34.
- Idem. The factual background for the treatment of progressive deafness from otosclerosis. Laryngoscope 1937, 47: 847.
- FRASER, J. S. Bilateral otosclerosis. Radical mastoid operation on worse hearing ear, etc. J. Laryngol. & Otol. 1935 50: 700.
- FRISVOLD, I. and DRESS, J. G. Critique of the present treatment of deafness due to lesions in the conduction mechanism. Arch. Otol. 1937 26: 159.
- HOLMGREN, G. The surgery of otosclerosis. Ann. Otol. Rhinol. & Laryngol. 1937 46: 312.
- HUGHSON, W. The inner ear from an experimental and clinical standpoint. Ann. Otol. Rhinol. & Laryngol. 1938 47: 68.
- Idem. Rationale technique, etc. with grafts in the round window. Laryngoscope 1938 48: 533.
- MOSELEY, H. P. Does animal experimentation show similar changes in the ear of mother and fetus after ingestion of quinine by the mother. Laryngoscope 1938 48: 361.
- LEMPERT, J. Improvement of hearing in cases of otosclerosis. Arch. Otol. 1938 28: 42.
- NEWBART, H. and HARTIG, H. E. Performance characteristics of electrical hearing aids for the deaf. Arch. Otol. 1936 23: 617.
- PERKINS, O. C. Dietary deficiencies as the etiologic factor in certain neurological syndromes. J. Nerv. & Ment. Dis. 1936 83: 505.
- SCOTT, C. R. H. I. Chronic infections in the pharynx. Tr. Am. Laryngol. Ass. 1936 p. 164.
- SELFRIDGE, GRANT. Chronic progressive deafness from a nutritional standpoint. A preliminary report. Ann. Otol. Rhinol. & Laryngol. 1917 46: 875.
- Idem. Can certain diseases of ear, nose and throat especially degeneration of eighth nerve be classified as deficiency diseases? Laryngoscope 1936 46: 83.
- Idem. Eighth nerve high tone deafness from a nutritional standpoint. Ann. Otol. Rhinol. & Laryngol. 1921 40: 93.
- SHAKELGH, G. F. Jr. Chronic progressive deafness including otosclerosis and diseases of the inner ear. Arch. Otol. 1937 6: 583.
- SMITH, J. MORRISSET. Surgical technique for the conservation of the hearing in chronic mastoiditis. Laryngoscope July 1938.
- SOURDILLE, M. New technique in surgical treatment of severe and progressive deafness from otosclerosis. Laryngoscope 1917 47: 833-873.
- Idem. Present position of surgical treatment of otosclerosis. J. Laryngol. & Otol. 1938 48: 51.
- TAYLOR, H. M. Deafness from drugs and chemical poisons. Laryngoscope 1937 47: 69.
- WALKER, H. Surgery of the nasopharynx in chronic progressive deafness. Laryngoscope 1938 48: 517.

# THE PHYLOGENETIC DEVELOPMENT OF THE EAR

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**K**NOWLEDGE of the phylogeny of the human ear involves a study of the organs of hearing of nearly related contemporary species as well as of species as remote in relationship as their occurrence in time

The fact that in many insects there are highly specialized organs for the production of sounds indicates that insects possess also the function of hearing. The sound-producing organs of grasshoppers and crickets probably produced the first not merely accidental and functionless sound in the history of life. It serves principally to bring the sexes together. The sound is produced by the friction of a file on the under side of the left forewing over a ridge on the upper side of the right.

Auditory organs in their simplest form consist of fine rods suspended between two points of the integument and connected with nerve fibers. This morphological unit may or may not be associated with a tympanum. The peg-like rod, with nerve attached, is known as the scolopophore. The wall of the scolopophore is composed at either end of 7 ribs, each of which is divided in the central portion, making 14 ribs. The entire scolopophore is bathed in fluid and is free to vibrate.

In other species, more elaborate organs are developed. In grasshoppers, highly specialized ears are situated, one on each side of the first abdominal segment. The tympanum is conspicuous as a thinned portion of the body wall. Closely applied to the inner surface of each tympanum is a ganglion known as Muller's organ. Intimately associated with Muller's organ are two horny processes (bone conduction) and a pear-shaped vesicle. Near the margin of the tympanum there is a spiracle, or the Eustachian analogue, which admits air to a space inside the tympanum, or the tympanic chamber. As the nerve endings in Muller's organ are attached to the tym-

panum, it is classed as a chordontal organ of the integumental type. The other type of chordontal organ ends free in the body cavity.

In the long-horned grasshoppers, known as locusts or katydids, and in the crickets there is a pair of tympana near the proximal end of the tibia of each foreleg. Some forms present an external canal. Within the legs bearing these tympana there are chordontal organs. There is also a trachea in each leg of a locust. The tracheas in the forelegs are remarkable for their great size and for the division into two branches. These two branches reunite beyond the end of the chordontal organs.

There are really 3 distinct types of chordontal organs, or cochleæ, in each foreleg of the locust. In the supratympanal form there is a ganglion composed of nerve endings which are scolopophores of the integumental type. Immediately below this is the intermediate organ in which the scolopophores are of the subintegumental type. Third, there is Siebold's organ, or crista acoustica, on the outer surface of the large trachea. This consists of a series of scolopophores which diminish in length toward the distal end of the organ. It forms a ridge on the trachea, therefore the name, "crista acoustica."

The hearing mechanism of the mosquito is connected with the antennae. At the bottom of the antennae is an enlargement, the scape, in which the muscles lie. Just above the scape is a greater enlargement, the pedicel holding Johnston's organ or the auditory apparatus, which differs in the two sexes, being more highly specialized in the male. Briefly, this organ consists of whorls of scolopophores, with their attached nerves. Experimentally it has been shown that the different whorls, which decrease in length on successive segments, are caused to vibrate by different notes (Mayer, 1874). It was formerly believed that the great specialization of Johnston's organ in male mosquitoes enabled the males to hear the songs of the females. But it has been

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found that in some species at least the females seek the males. Rudyard Kipling may not have had this in mind. The fact remains, however, that the distinctive feature is the presence of scolopophores, which is characteristic of the auditory organs of other insects. The grasshopper has its hearing mechanism in the abdomen, the cricket, in the foreleg, the mosquito, in the antennae. Apparently, nature has cared very little where she put this organ so long as it functions.

When and in what form, did this function of hearing first appear? Who was the first listener? If a fish is sensitive to vibrations of similar frequency in the water, is that analogous to hearing vibrations in the air? And, if so, is the sensitiveness of an earthworm to vibrations in the surrounding soil similar—and the earthworm has a head brain—or must we classify it as a different sense? The sense of hearing and the sense of touch are closely allied and it is hard to draw the line between them and to differentiate which shall be called hearing and which not. In certain insects, however, a real sense of hearing exists which is in some way comparable to our own. In fact there is a striking similarity of mechanism manifest in the parallel development of the invertebrate and vertebrate lines.

The earliest ear structures are associated with the static and kinetic labyrinth. The invertebrate crayfish, a glorified worm and descendant of the trilobite, has a statolith, and it most probably appeared upon the scene earlier than the vertebrate lamprey and hagfishes with their utricle and sacculus. The sacculus becomes progressively differentiated into the lagena and eventually into the cochlea. The utricle and semicircular canals show far less change. With the substitution of air for water the invertebrates develop a more delicate mechanism, as demonstrated in the scolopophore. Inasmuch as scolopophores are found in the worm or embryonic stage of some flies it would seem to predicate the presence of hearing elements in very early extinct forms. The premise of this conclusion rests in the fact that the embryo in its development repeats the history of the race and so in this instance it would carry the function of hearing back to an aboriginal wingless stock.

Let us view in retrospect in order to make a reckoning in geological time. For instance consider the Archeozoic or pre Cambrian period, 1,850,000,000 years ago according to Schuchert and Dunbar, when the diggerminal forms were just getting under way, or just a little later, perhaps when the mid Cambrian trilobite was flourishing 6,000,000 years ago. Some forms of these Crustacea have remained unchanged generically over the same span of time and swarm in the oceans today illustrating the principle of balance or stability of type. While fossil forms would indicate that the harlequin fly developed this side of the Carboniferous period, 300,000,000 years ago, still the presence of scolopophores in this fly's larva as might, as mentioned, point to the occurrence of the same in an early form and at an early date. And so it seems reasonable for us in this political time and in the current parlance to choose the initials P E Z (Paleozoic) and push back the first listener a few odd hundred million years.

The central line of fish evolution destined to give rise to all the higher and modern fish types, is found in the typical cartilaginous skeleton, jaws and four fins of the primordial sharks of Upper Silurian time, 500,000,000 years ago. The question, "Does a fish hear?", would seem to be answered with the presence of a primitive lagena. While both the shark and the carp family have primitive lagenae the shark has microscopically more elements.

In the brains of the animal, from fish to man, the cochlea is associated with a center in the mid brain. The conditioned reflex for hearing in fish was established by H. A. Bull and reported in 1930. And we have the familiar example of driving herring into nets with the beating of pans.

We have the seeming paradox of fish with ear bones or ossicles. The system of bones is analogous to that found in higher vertebrates but it connects with the lungs or air bladder and not with the tympanum. For that reason the ossicular chain is limited to the group of lungfish or to the teleosts with an equivalent of the lung which is the swim bladder. The arrangement for this purpose is especially elaborate in the carp or catfish families. Weber, in 1820, described a series of paired

ossicles which he erroneously called stapes, malleus and incus, which, as shown in the carp, connect a part of the inner ear, the atrium sinus impar with the swim-bladder. It is also of interest that the tubular sinus impar, aside from connecting the ossicles with the lagena, also directly connects the two labyrinths. The entire apparatus would then function as an organ of hearing. Weber's views remained practically uncontested for half a century, but recently much has been written both for and against this theory. The bones are not homologous with those of the ear of higher mammals, however, being processes of the anterior vertebrae. Those of higher mammals develop from the multiple jaw bones, as seen in the crocodile or alligator.

The sharks and the lung fish (*squalus acanthus*) are alike in this respect, there is a small canal extending from the labyrinth to the surface of the skull. However, the shark has no lungs or swim bladder and, therefore, no weberian ossicles. The air bladder or swim bladder is closed as an organ of respiration, although it has taken on collateral functions. It picks up vibrations as through bone conduction, transmitting them to the ossicles. It also acts as a hydrostatic organ of equilibrium by aiding in the decompression of air from the vascular content in coming from the deep. In other words, it serves as the decompressor chamber of the caisson worker. It is said that when some of these fish are brought from a depth in a certain European lake the swim bladder becomes so large the fish cannot navigate. However, after being stuck with a pin, they swim in the shoal water perfectly.

Finally, Moreau has drawn attention to the *Trigla* (red mullet), a fish having an air bladder supplied with muscles which serve to make the air bladder produce a sound. So you see, we finally have the fish in the position where he is talking. What does he say?

Certainly through all phylogenetic progress the cosmic processes cease to run down and begin to build up, abandoning old forms and constructing new ones. In like manner, in the amphibian and reptile, the lower jaw produces the analogue of the ossicles in man. Below mammals, an entirely different type of middle ear anatomy is found. The reptiles

show a complex evolution in which the half dozen or so bones of the lower jaw are lost one by one, the three bones closest to the jaw articulation leave the lower jaw and become associated with the skull. The ear structures which, in reptiles, are outside of the skull, in mammals, become enclosed in it. The lower jaw articulates in the alligator by means of an extra bone (the quadrate) as well as with an articular cartilage. In some forms of reptiles, as for example the *Anomodontia*, the articular bone articulates not only with the quadrate but also, to a large extent, with the squamosa, the quadrate shrinking in size and developing processes which give to it very much the appearance of either the incus or the malleus of the mammalian ear. As a matter of fact, it fits in with a fair interpretation of the parts of embryology. The stapes is the equivalent of the columella in the reptile; the articular is represented by the malleus, and the quadrate, by the incus. The skull of the mammal differs from that of the lower vertebrates in that it is a more consolidated whole. The numerous parts from which the mammalian jaw ossifies is reminiscent of the former state.

The sense of hearing in reptiles is apparently not very acute, although tortoises and turtles are frightened by noise and can distinguish sounds. If it were not so, they would have no voice, which is very tiny and piping in most tortoises during the pairing season. In most water tortoises the tympanic membrane is thin and quite exposed. Lastly, in *Chelone*, the tympanic cavity is filled with a plug of the much thickened skin, possibly an adaptation to the water pressure when these creatures dive to considerable depths. In the crocodile, the outer ear lies in a recess and this carries a flap of skin provided with muscles to close the ear tightly. The tympanic membrane is visible at the bottom of the recess and, shining through it, is part of that cartilage which is homologous with the malleus of the ossicular chain. Diverticula from the middle ear penetrate the bones of the rear of the skull and form pneumatic spaces in these heavier regions of the skull. The ear is likewise peculiar in snakes. There is a long columellar rod with a fibrous or cartilaginous pad at the outer end which plays against the



middle of the shaft of the quadrate, an arrangement, which we must assume, produces a thundering noise in the inner ear, since every motion of the quadrate during the act of swallowing conveys the vibration directly to the fenestra ovalis. The tympanic cavity, eustachian tubes, and tympanum are abolished and no external traces of the ear are visible.

The croaking of male frog like amphibia is almost certainly life's first vocal music. The frogs have simple middle ear expansions containing air and apparently there are no diaphragmata from the main cavity.

According to Henry Fairfield Osborn, founder and former president of the American Museum of Natural History, the dinosaur had a mastoid. In the field of paleopathology, the dinosaurs, considered extinct reptiles of the Triassic period, 150,000,000 years ago, showed evidence of arthritis deformans. It is a matter of reasonable conjecture that the earliest evidence of inflammatory change in bone or mastoiditis might be found, therefore, in this fauna. Why did the dinosaur have a mastoid? The next appearance of a pneumatized mastoid process is found in the anthropoid apes, a development of about 65,000,000 years. Where was the invisible evolution of the hereditary germ carried those 85,000,000 years? Or should this interval be considered as that of the "Dark Ages" of the mastoid?

The birds resemble the reptiles among other things in having no ear trumpet or pinna. Their sense of hearing is acute but it has been observed that many kinds of birds are indifferent even to loud noises. Attention is most readily given to sounds which stimulate interest in an inborn equipment or an acquired association. The parental danger note stimulates the crouching instinct of the young partridge. The semi-circular canals of the ear show some correlation with the perfection of flight. They are better developed in a swallow than in a swimming bird.

In some forms of the owl, the external canal reaches nearly the whole height of the skull, being directed upward and downward. In *Nyctala* this asymmetry extends to the bones of the skull itself. The large ear is apparently correlated with a keen sense of hearing in some cases but not in all. It has been suggested

that the development of the mastoid may be secondary to the pull of muscular attachments. But, consider the owl, his eyes are practically fixed and to change his line of vision he has to move his head which he accomplishes in an arc of 270 degrees. Should he not have the mastoid?

As a proof, among others, that the whale is the progeny of terrestrial creatures, are occasional traces of external ears. The bones related to the organ of hearing, the tympanics and petrous bones, are very solid and dense in structure. Moreover, they are but loosely attached to surrounding bones and are thus easily and frequently lost. In whalebone whales the external canal is blocked by a large mass of wax several inches in length which would greatly interfere with hearing. It is believed that vibrations in the water reach the ear by sacs, given off by the eustachian tubes or by bone conduction. In the seal the external ear has vanished. In the sea lion, the external ear though small, is persistent. The ossicles differ from those of terrestrial allies in their large size and massive growth. In this they have come to be like those of the whales.

Bats are on the lookout, of course, for the sounds of insects and require an acute ear but the fact that their flight is directed by a "sound beam," the echo of the sound they emit, their hearing must be most acute to use these reverberations at the speed they fly.

It cannot be doubted that the increased complexity of the brain of mammals raised them in the scale as does also the delicately adjusted series of bonelets in the middle ear. In connection with the elaboration of the chain of auditory ossicles, it is very usual for mammals to possess a thin inflated bone, sometimes partly or entirely formed out of the tympanic bone, the tympanic bulla.

The tympanic bulla of dogs is often very much inflated, if flatter, as in bears, it is still large and conspicuous. In the bear like *Canis* a fairly typical arctoid bulla is seen, but, as a group, the bulla flattens off toward the bony meatus in the raccoon, the bulla is much smaller, in the polecat, it is fairly swollen but there is a little flattening toward the meatus. In cats, there is a double cavity

in the bulla almost separated by a septum, in the pig, it is divided by many septa into a cancellous structure.

It is convenient to mention, here, a curious fact that white cats with blue eyes are said to be always deaf. Should the mother produce a litter of kittens and any one of them has a single speck of color on its fur, it invariably possesses the usual faculty of hearing, but, if perfectly white, it is invariably deaf.

All the lemurs of Madagascar differ from the African forms in that the tympanic ring is completely enclosed by the bulla ossea, but without osseous connection with the same.

Valsalva, in the seventeenth century, observed that those animals having no mastoid cells have large tympanic cavities or bullas. Phylogenetically, the mastoid cells are not found in animals below the level of the apes. There is a considerable pneumatization present in the chimpanzee and the gorilla. The chimpanzee has no antrum, while the gibbon and the orang have no mastoid process. In the common rhesus monkey the petrous bone is cancellous with cavities connected by many small openings into the tympanic cavity. The arrangement obviously differs from that of the higher apes and man. Various groups of mammals have diverticula from the middle ear into the petrous, squamous bone, or zygomatic arch. Some of the marsupials have actual continuities from one middle ear to the other by means of cancellous tissue, and apparently the sphenoid can be so traversed.

Finally, and briefly, there are 3 groups with diverticula from the middle ear, namely, (1) certain reptiles and birds in which the diverticula are not surrounded by bone, (2) mammals in which the simple diverticula are surrounded by bone, and (3) the great apes in which there are diverticula in cancellous bone. In the human and gorilla there can be no doubt about the terminology, mastoid cells.

Something of the phylogenetic development of the mastoid process as it immediately applies to man, more particularly in his primitive state, is included here.

The recent discovery, November, 1936, of three remains of Peking man has afforded the opportunity of showing here the rudimentary mastoid process of our most ape-like relative,

who lived 600,000 years ago. The elongated low brain case and large supra-orbital ridges show relationship to the apes. Ability to make fire and to use tools, together with the capacity of the brain case, proves the Peking man to have been a human. The mastoid process, shown in relation to the external osseous canal, appears to be more rudimentary and more like that of the ape than that of any known man. It is shown in comparison with the skull of the Peking man, the chimpanzee, the Neanderthal man, and a North China modern.

Later computations on the age of the Neanderthal skull places it at about 200,000 years. It is apparently better developed than the Mongoloid or Peking man of 650,000 years. *Pithecanthropus* is probably about the same period as the Peking man, or perhaps a little older, but the lower temporal regions are missing. Sir Arthur Keith's projection of this area looks just about like the skull of the Peking man.

In skulls of the modern type, a pyramid-shaped process of bone, the mastoid process, descends immediately behind the ear. To this process certain muscles of the neck, concerned in moving the head, are attached. It is only slightly developed at birth, attaining its full size when the individual has reached adult life. In the gorilla, a mastoid process is present, but, instead of growing downward to form a pyramidal process, it expands into a flange-like plate, forming part of the bony occipital platform on which the muscles of the neck are implanted. The pit or fossa from which the digastric muscle arises is thus left exposed on the anthropoid skull below the mastoid process. In skulls of the modern type, the pyramidal process covers and hides the digastric fossa. In the Neanderthal skulls, the mastoid process does not assume a distinct pyramidal form. In its shape and relations, it is intermediate to the form seen in young anthropoids and to that in men of the modern type. It will thus be seen that in the mastoid region even the Neanderthal skulls show a series of characters which may justly be regarded as simian in nature and origin.

The function of the mastoid portion of the temporal bone has not been clearly determined. The mastoid is not even vestigial as

the vermiform appendix or some other structures, the removal of which has not shortened life or impaired physiological processes. Nature apparently abhors too much cortical bone, preferring a trellis work of cancellous structure paranasal sinuses and, may I add, the cellular structure of the mastoid.

## BIBLIOGRAPHY

- 1 BEDDARD F E *Cambridge Natural History* Vol 10 p 206 London MacMillan & Co Ltd 1904
- 2 BRIDGE T W *Cambridge Natural History* Vol 7 p 207 London MacMillan & Co Ltd 1904
- 3 BULL H O *Science Progr* 1930 25 97
- 4 COMSTOCK J H *An Introduction to Entomology* P 145 Ithaca N Y Comstock Publishing Co 1936
- 5 DE CHARDIN T *Our most ape like relative* *Natural History* 1937 40 514
- 6 EVANS A H *Cambridge Natural History* Vol 9 p 390 London MacMillan & Co Ltd 1904
- 7 EVANS H M *The origins of hearing* *J Laryngol* 1916 30 649
- 8 GRAY A A *The Labyrinths of Animals* Vol 1 London J and A Churchill 1907
- 9 CADDOW HANS *Cambridge Natural History* Vol 1 p 445 London MacMillan & Co Ltd 1904
- 10 HARTMAN C G and STRATTS W L Jr *The Anatomy of the Rhesus Monkey* P 347 Baltimore The Williams & Wilkins Co 1933
- 11 HART ROBERT *Personal communication*
- 12 JORDAN D S *A Guide to the Study of Fishes* Vol 1 p 119 New York Henry Holt & Co 1909
- 13 KEITH ARTHUR *The Antiquity of Man* Vol 1 p 712 London Williams & Norgate Ltd 1910
- 14 OSBORN H F *The Origin and Evolution of Life* P 121 New York Charles Scribner's Sons 1930
- 15 Idem *The Age of Mammals* P 8 New York The MacMillan Co 1921
- 16 RETZIUS OSMAR *Das Gehör Organ der Wirbeltiere* Stockholm 1884
- 17 STETTER H *Untersuchungen ueber den Gehorsinn der Fische* *Ztschr f vergl Physiol* 1929 9 Nos 2 and 3
- 18 THOMSON J A and GEDDES P *Life* P 123 New York and London Harper & Bros 1931
- 19 WEIDENREICH FRANZ *The James Arthur Lecture* *American Museum of Natural History* 1931

## OCULAR MANIFESTATIONS OF ALLERGY

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CLOSE observance by practitioners during the early Christian era proved that food for one man was poison for another. In 1796 Edward Jenner vaccinated for smallpox successfully, Magendie produced anaphylaxis by injections of egg white in rabbits, Pasteur used bacterial inoculation, and Flexner's work on anaphylaxis appeared during the latter part of the nineteenth century. A great amount of forward, constructive work has been done by many brilliant men, too numerous to mention. The foreword written by Woods, to *Allergy and Immunity in Ophthalmology*, by Dr Wilmer, gives a beautiful description of the history of allergy.

Following the epoch making discoveries of the phenomena of anaphylaxis, numerous investigations were conducted to determine the relationship of the processes of hypersensitivity to diseases of the eye. These and other experiments have indicated that the tissues of

the eye, like most tissues, take part in the immunological reactions of allergy with the production of antibodies or of cellular reactions not unlike allergic processes elsewhere. They suggested that allergic reactions may be responsible for certain ocular conditions which were attributed formerly to some other cause. Thus, until recently, the only allergic condition which concerned the ophthalmologist was the conjunctivitis accompanying hay fever, since this necessitated differentiation from other types. Recent reports of the possible allergic character of vernal conjunctivitis, and of so called "allergic cataract," as well as the relationship of bacterial allergy to certain inflammatory conditions of the eye have stimulated study of the possible relationship of allergy to these ocular abnormalities.

## ETIOLOGY

A disturbance of the endocrine glands has been cited as the cause of every disease of obscure etiology. Spring catarrh is no exception to the rule, and many writers have been

## TYPES OF ALLERGIC MANIFESTATIONS OF THE EYE AND ITS ADNEXA

- 1 Allergic conjunctivitis
  - a acute
  - b chronic
- 2 Vernal conjunctivitis
  - a corneal type
  - b lid type
- 3 Cataract
- 4 Sympathetic ophthalmia
- 5 Corneal ulcers
- 6 Focal eye reactions due to bacterial allergy
- 7 Tuberculous infection of the eye
- 8 Lesions of the retina and optic nerve
- 9 Visual allergy
- 10 Ocular headaches due to allergy

## ORGANS AND TISSUES INVOLVED IN THE EYE

- 1 Peri-orbital tissues—edema
- 2 Skin of eye-lids and lid margins—urticaria, edema, contact dermatitis
- 3 Conjunctiva—allergic conjunctivitis
- 4 Cornea—allergic keratitis
- 5 Uveal tract—uveitis, cataract
- 6 Retina and choroid—edema with loss of vision
- 7 Optic nerve—edema with loss of vision

struck by the clinical picture of vagotonia presented by their patients—a preponderance of the vagal over the sympathetic element in the vegetative nervous system with lessened suprarenal activity Angelucci (1898) pointed out the frequency of vernal conjunctivitis in persons of a lymphatic type, defining a diathesis characterized by vasomotor lability, tachycardia, lymphoid hyperplasia, and general hypo-adrenalism (Angelucci's syndrome) After him many observers have noted dysfunction of the thyroid, parathyroid, suprarenal, and sexual glands (Lagrange, 1922–35, Santori, 1927, Lemoine, 1929, Lagrange and Delthil, 1932, and others) Vagotonia has been specially stressed by Guerra (1929), Mamoli (1930), Ferrari (1930), and Casini (1932), and it has been associated with infantilism, the status thymolymphaticus, eosinophilia, and a relative lymphocytosis (Rizzo, 1924, Genaro, 1928) It would appear that the evidence is strong that vernal conjunctivitis is frequently, and by no means invariably associated with constitutional disturbances of this type, but it is weak if taken to imply that such a diathesis is itself causative We are on safe ground only if we admit that these factors, about which we know very little, and that

little vaguely and indefinitely, form a suitable soil whereon the disease may readily flourish

The theory that vernal conjunctivitis is a manifestation of an allergy has the most definite evidence to support it, but even that is not conclusive On general pathological lines such an etiology is possible, for the two types of lesions which occur are analogous to other conditions which are almost certainly allergic, the one conforming to the pathology of a phlycten and the other to a cutaneous eczema. The clinical evidence in favor of this hypothesis is considerable, namely, the tendency to attack the young, the seasonal occurrence of the attacks, and the type of secretion with the presence of eosinophils The theory must stand or fall, however, on the evidence of specific hypersensitivity in affected persons, the demonstration of other symptoms characteristic of allergy with a familial tendency, and the response to treatment by exclusion of the allergen or desensitization to it; and while there is a considerable amount of positive evidence available, it cannot be said to warrant universal acceptance

The existence of a specific sensitivity to pollens, animal inhalants, foods, and so on, has been investigated by several workers. Lagrange (1922), Fort (1923), Townsend (1923), Lemoine (1925–29), Weinstein (1931), and others, found that the great majority of patients were pollen-sensitive, others obtained indeterminate results (Teller, 1932), while still others (Guerra Paolo, 1929, Thommen, 1931) failed to confirm them Lehrfeld (1925–32) in a large series of patients found 30 per cent sensitive to various allergens, when given intradermally in large doses, and exhibiting other allergic manifestations He also obtained a recrudescence of the symptoms in the quiet winter period by instilling some of the irritant into the conjunctival sac Its association with hay fever has also been stressed by Townsend (1923), with vasomotor rhinitis by Mamoli (1930), with asthma by Weinstein (1931), and similar evidence has been brought forward by Seefelder (1911), Kruckmann (1930), and others

*Acute conjunctivitis* The term, allergic conjunctivitis, is employed usually when referring to the acute inflammatory condition of the

conjunctiva which is seen in patients with hay fever. Here, the conjunctival mucous membrane contains cells sensitized to pollen and as a consequence, contact with pollen produces an allergic reaction. This is manifested by a conjunctivitis which may be reproduced easily outside of season by instillation of dry pollen or pollen extract into the eye. The degree of sensitivity and the extent of the contact will determine the severity of symptoms. They may be mild and scarcely noticeable in some patients or be marked and cause considerable discomfort in others.

The most pronounced symptoms of this condition are itching, lacrimation, and some photophobia. These patients frequently report for examination wearing colored glasses. The secretion present is usually watery and thin or possibly slightly mucoid. The latter type is found, as a rule, in the morning on arising and shows a predominance of eosinophils upon examination of the stained smear.

Inspection of the eyes in these patients will reveal definite evidence of conjunctival inflammation, the degree of which depends upon the severity of the reaction. The vessels of the conjunctiva, both around the cornea and beneath both lids, are injected and the mucosa itself looks swollen or edematous either in its entirety or in localized areas. In the severer types, the lower lids may be swollen or puffy, due to the edematous involvement of the loose subcutaneous tissues.

Edematous, loose tissue beneath the lids is often hard to explain to the patients after a negative history of insomnia, excessive dissipation, or kidney disease. It then behooves the ophthalmologist to make a careful check for the offending allergens.

These characteristics may be more marked during hay fever season in all patients. It seems to be the consensus of opinion among allergists, and I have found it true in my practice, that the allergic patient is sensitive to a number of different allergens. Bags beneath the eyes occur more often in adults than in children. In a smaller percentage of patients the eye symptoms will predominate almost to the exclusion of the nasal symptoms which may be very slight or insignificant. This is the type of patient who consults the

ophthalmologist first, because he believes that there is something wrong with his eyes. It is important that the practitioner recognize the possibility that this condition is allergic in character rather than attribute it to bacterial infection or to eye strain.

The differentiation of the type of conjunctivitis seen in hay fever from other forms of acute conjunctivitis is not difficult. The seasonal occurrence, the intense itching and the absence of mucopurulent discharge containing a predominance of neutrophilic leucocytes and bacteria, and the positive skin reaction to pollens, are sufficient to distinguish it from acute catarrhal conjunctivitis or "pink eye" due to infection.

**Chronic conjunctivitis.** Chronic conjunctivitis of the allergic type, and similar to that seen in patients with acute hay fever, is occasionally observed in those hay fever patients in whom the eye symptoms are especially predominant. In these patients the repeated conjunctival irritation results in a low grade inflammatory condition of the lids, which appear thickened and more or less continuously reddened. The acute inflammation subsides usually with the termination of the hay fever season but persists in a mild form throughout the year. The eyelids of these patients show a tendency to stick together on arising, due to the presence of a thickened mucoid discharge. Although the primary factor in these instances is usually a pollen, the possibility of sensitivity to some other inhalant, like dust, feathers or ornitho root should be kept in mind, especially in those instances in which the eye symptoms are perennial in character. The diagnosis and treatment of this type is similar to the acute form.

Allergic conjunctivitis, of either an acute or chronic type, in some instances may be the result of sensitiveness to agents other than pollen. Examples of such agents are eyelash dyes, tints, cosmetics, and the different chemical solutions, such as butyn, pontocaine, atropine, bichloride, eserine, and pilocarpine. These products produce rather violent reactions in the eyelid and conjunctiva as a result of marked sensitivity. In this instance, the reaction is in reality like a contact dermatitis. Skin reaction by the scratch or intracutaneous

methods is negative, as would be expected. Cosmetics containing heavy metals, perfume, orris root, certain hair dyes, or even silk, may produce a similar reaction in sensitive individuals, although this is likewise uncommon.

*Vernal conjunctivitis.* There is little or no question among allergists or ophthalmologists as to the allergic character of the conjunctival conditions thus far discussed. Considerable controversy has arisen, however, concerning the possible allergic basis of the condition known as vernal conjunctivitis, also called "spring catarrh" or "vernal catarrh." This condition is a subacute or chronic form of conjunctival inflammation, which begins characteristically with the onset of the warmer months, particularly in the late spring or early summer, and persists usually as long as the warm weather lasts, which accounts for the use of the term "vernal." It is characterized clinically by itching and redness of the eyes, lacrimation, photophobia, and aropy lardaceous type of discharge which causes the eyelids to stick together especially on arising in the morning. Symptoms are usually worse in the late evening and on contact with heat.

Depending upon the location of the lesions upon examination, two distinct types of vernal conjunctivitis have been distinguished. (1) The limbic or corneal type, characterized by the appearance of discrete vesicles occurring at the margin of the cornea. These may become confluent and completely encircle the corneal border, giving it an "icing" or "frosting" appearance. (2) The lid type involves the lids only. Lehrfeld distinguishes three separate varieties: a, simple follicular, b, cobblestone, and c, granuloma. These may be spoken of as separate varieties but some authors think these are just a continuation of the first form. These are all characterized by red eyes, lacrimation, heavy mucoid discharge, itching, and photophobia. Smears prepared from these secretions by Giemsa stain reveal the presence of eosinophiles in large numbers.

The two types, corneal and lid, rarely if ever co-exist in the same patient. The appearance and locations of lesions are different. Itching is less prominent and mucous discharge scantier in the corneal variety. This type usually disappears with the onset of cold

Pollinating Grasses during Vernal Conjunctivitis Season (from May 15 to September 15).

Grass Combination No. I—Early Spring

(May 15 to July 1)

June grass	5
Orchard grass	2
Bermuda grass	1
Sweet vernal	1
Plantain	1

Grass Combination No. II—(June 15 to August 1)

Plantain	1
Bermuda grass	1
June grass	1
Johnson grass	1
Timothy	4
Redtop	2

Grass Combination Mixture No. III—  
(August to September)

Bermuda grass	4
June grass	2
Johnson grass	2
Plantain	2

Allergic conjunctivitis due to pollens from (August to latter part of September)

Combined Weeds No. I

Short ragweed	5
Giant ragweed	2
Southern ragweed	1
True marsh elder	1
Burweed, marsh elder,	0 5
Cocklebur	0 5

Combined Weeds No. II

Russian thistle	2 5
West water hemp	2 5
Lambs quarter	2 5
Pigweed	2 5

Allergic conjunctivitis most commonly seen from August on

Combined Grass and Weeds

Grass No. III	10 per cent
Combined weeds No. I	70 per cent
Combined weeds No. II	20 per cent

The allergic conjunctivitis which persists may be carried through the winter by vaccines, autogenous and occupational dusts

weather, whereas the lid type usually starts in the early summer months, and ordinarily is due to the early pollinating grasses acting as the offending irritants. A number of these early grasses pollinating from May 15 to July 1, are June grass, orchard grass, Bermuda grass, sweet vernal, and plantain. Carried on from June to August are Johnson grass, timothy grass, and redtop. From August to September there is the continuation of Bermuda, Johnson, June, and plantain. The latter part of September the corneal or limbic type of conjunctivitis may disappear, but there will be a continuation of the lid type by irritations from pollination of short, giant, southern ragweed, true marsh elder, burweed, cocklebur, thistle, western water hemp,

lambs quarter, and pigweed Foods, house and occupational dust, and animal emanations, such as horse and dog dander, may act as continuous exciting factors throughout the year

**Cataract** The possibility that cataracts, especially the type occurring suddenly in young people, may be allergic in origin has been suggested recently The antigenic properties of lens protein have been recognized for many years Various experiments have shown, for example, that beef lens protein is identical in its antigenic properties with the lens protein of other animals, although different from other types of organ proteins

In 1922, Verhoeff and Lemoine suggested that the inflammatory reaction of the eye or endophthalmitis, which occurred in certain patients after cataract extraction or after a second discussion in children, might be the result of an allergic reaction to the lens protein left behind in the chamber They called this type of reaction endophthalmitis phacoanaphylactica and established it as a clinical entity The existence of hypersensitiveness in these patients was indicated by positive skin reactions to lens protein and also by the fact that injection of lens protein extract for purposes of desensitization was followed by rapid subsidence of the inflammatory reaction

These findings have been fully confirmed by other observers, who likewise have shown that certain patients with cataract will give a negative skin reaction to lens protein before operation and a positive reaction afterward, especially if an endophthalmitis develops after operation It is generally agreed, therefore, that the postoperative inflammation following cataract extraction is an allergic phenomenon and that desensitization with lens protein extract is an indicated and valuable procedure in these patients

The relationship of lens protein to the development of cataract, however, is not defined as clearly Attempts have been made to treat cataractous patients with lens protein extract and although either total arrest or definite improvement has been reported in a large percentage of patients, these results have not been confirmed experimentally and are not generally accepted The only suggestive

evidence of a relationship is the report of the successful production of certain lens defects in a strain of guinea pigs, whose heredity had been followed for several generations and in which no lens defects had occurred previously The mechanism by which these defects were produced awaits experimental confirmation

That cataract also may result from an allergic reaction to proteins, other than lens protein, is indicated by the reports of patients in whom the cataract occurred in association with a definite allergic manifestation The cataracts in these patients were always in a association with atopic eczema Positive skin reactions were obtained in nearly all instances These findings have prompted the application of the term, "allergic cataract," or "cataracts associated with allergy," to these cases

In discussing the ocular antaphylaxis Lemoine covered this subject very thoroughly with Verhoeff and McDonald At the present time I am treating 7 patients with bi weekly injections of lens protein<sup>1</sup> sterile solution of 2 per cent from cattle eyes All these patients varying in age from 35 to 72 years, have incipient cataracts They were given a complete physical examination, and after the foci of infection had been eliminated as nearly as possible, special attention was given to the patients' endocrine balance and vitamin intake They were started on a dosage of two tenths of a cubic centimeter with increasing graduate doses to 10 cubic centimeters It is too early, however, to evaluate this problem This work has been done previously by other men claiming various results

**Sympathetic ophthalmia** The reason for the occurrence of an inflammation of a normal healthy eye in a patient who incurs an injury in the opposite eye has been the subject of considerable controversy Experimental and clinical observations by Elschnig and by Woods have indicated the possibility that this condition likewise may be the result of an allergic reaction, produced by a hypersensitivity to the uveal pigment The latter also has been shown to possess antigenic properties distinct from that of lens protein As evidence of hypersensitiveness Woods reported the occurrence of positive intracutaneous skin

<sup>1</sup>Le proteinum of the eye by Sh. P. & D. Inc. Philadelphia

reactions to uveal pigment in patients with sympathetic ophthalmia, whereas control patients gave negative reactions. He found that negative skin reactions occurred in the acute stages of the disease, just as they did in the tuberculin allergy of acute tuberculosis. On the basis of these findings, Woods used uveal pigment therapeutically in patients with sympathetic ophthalmia and reported favorable effects. These findings, while distinctly suggestive, are not as yet generally accepted.

*Corneal ulcers* Isolated cases have been reported in recent literature in which an ulcer of the cornea affected an allergic individual as the result of specific hypersensitivity. Lemoine in 1925 reported a series of 6 cases. Parlato reported an ulcer in an individual who had ocular symptoms in association with coryzal symptoms and who was found specifically sensitive to orris root. Allergic therapy including orris root desensitization proved effective. The appearance of such ulcers as the result of specific hypersensitivity is rare and should be suspected only when they occur in a definitely allergic individual. The exciting allergens in Lemoine's cases were both pollens and foods.

*Focal eye reactions due to bacterial allergy* There is ample clinical evidence to justify the suspicion that certain inflammatory conditions of the eye, notably iritis, are due to an allergy to bacteria present in such foci of infection as the sinuses, teeth, tonsils, gall bladder, etc. That these foci of infection have a definite etiological relationship is rather generally accepted and is proved by the frequency with which their eradication is followed by disappearance of the eye condition, and also by the occasional flare-ups or focal reactions which follow the removal of the infected focus, or the subcutaneous injection of a vaccine prepared from the bacteria cultured from the focus.

Many successful attempts have been made to obtain living organisms from the secondary focus in the eye. It is obvious, therefore, that the ocular inflammation is not produced by the bacteria themselves but is the result of the action of their toxic products.

*Tuberculous infections of the eye* The relationship of allergy to tuberculous infections of

the eye has been studied extensively. Such infections are always of endogenous origin and occur in previously infected individuals. The exact part played by allergy and immunity in relationship to these ocular infections is controversial.

According to Woods, conclusive evidence indicates that the phlyctenules of phlyctenular keratoconjunctivitis are the result of an allergic reaction of the sensitized surface of the cornea and conjunctiva which may result either from a small early tuberculous focus in the eye or as part of a general hypersensitivity to tuberculin protein from lesions elsewhere in the body. On the other hand, there seems to be no definite evidence to indicate that an allergic factor exists in tuberculous interstitial keratitis or in tuberculosis of the uveal tract.

*Lesions of the retina and optic nerve* These structures are rarely the seat of primary allergic reactions. They may be involved secondarily as part of a general allergic reaction, as in the case reported by Bedell in which edema of the nerve head and retinal hemorrhages occurred as part of a serum reaction following the administration of tetanus antitoxin. In another case reported by Coca, simple edema of the left macula occurred each summer in an atopic patient who had gastrointestinal allergy and migraine.

Involvement of the retina by edema or of the retinal vessels (spasm) probably accounts for the ocular symptoms accompanying migraine (scotomas, photophobia, etc.). A similar explanation may be given for those isolated instances of diplopia, temporary blindness, or hemianopsia which are the result of allergy to foods like chicken or fish, although the exact mechanism is not known.

Some attempt has been made to attribute certain instances of retrobulbar neuritis to the pressure of the marked edema incident to an allergic reaction in the adjacent ethmoid or sphenoid sinuses. All 6 cases reported by Hansel cleared up with local treatment. These instances are the exception rather than the rule.

*Visual allergy to light.* This term has been applied to abnormal ocular reactions to ordinary amounts of light. According to Lehrfeld, "It is principally a physical allergy, not in



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Vernal conjunctivitis	Spring and early summer	Ropy thick	Eosinophils	Marked	Marked	Yes	Some
Bacterial conjunctivitis	All year	Thick muco- purulent	None	Some	Marked	Yes	No
Trachoma	All year	Thin watery	None	Marked	Marked	Yes	No

any way related to immunological sensitivity but certainly related to urticaria solaris and to urticaria dermatographica. It is not an allergy in the sense that there exist antibodies or reagins which are clinically foreign to the tissue cells."

Lehrfeld points out that tolerance or intolerance and visual allergy to light is intimately associated with the pigment content of the choroid, retina, and iris and that when this is deficient, tolerance to light is also decreased. This can be corrected to a considerable extent by the addition of pigment in the form of tinted lenses. The use of such glasses has been found very valuable for this purpose.

**Ocular headaches due to allergy.** After a careful correction of the errors of refraction and a search for pathological conditions of the eye, the ophthalmologist is often unable to make a diagnosis of the patient's headaches. It would then be well to take a careful history of the patient with reference to foods, endocrines, vitamins, and so forth. It is well to keep in mind that the eye symptoms may be due to a nasal allergy giving the referred discomfort to the eyes.

#### DIAGNOSIS

A careful history is of the utmost importance. It gives leads to the offending allergens, which may be preseasonal, seasonal, or perennial. Eye secretion smears should be prepared by means of Giemsa stain. Tests should be made for food, pollen, dust, and so forth, and there should be cut and scratch tests, intracutaneous, passive transfer, mucosal, ophthalmic, and patch tests, and the leucopenic index should be taken. Special attention should be given to endocrine balance and vitamin intake in order to establish

correctly the basal metabolic rate. A questionnaire should be given to the patients to take home and to fill out, and a complete physical examination of each patient should be made.

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#### TREATMENT

**Symptomatic.** Secretion should be removed from the eyes 3 times a day by irrigation with a dropper. The patient is given a 16 ounce bottle of solution containing 1 grain of salicylic acid, 2 grains of zinc sulphate, 1 dram of sodium borate, 1 ounce of aqua camphora and distilled water sufficient to yield 16

ounces Although the hydrogen ion concentration of the eye secretion is always high, this seems to give more relief than straight alkaline solutions Ten minutes after each eye is irrigated, there should be the instillation of 1 drop in each eye of the following solution: 1 grain of suprarenin bitartrate, 1 grain of zinc sulphate, and saturated solution of boric acid sufficient to yield 1 ounce. One per cent holocaine solution may be added to this mixture, if desired to control pain This is followed by an ice pack

This, in my hands, has given a great deal of relief. The patient is also asked to take 1 to 2 capsules a day. Each capsule is composed of one-eighth grain of powdered neo-synephrin, one-eighth grain of sodium phenol barbital, 2 grains of aspirin, and 3 grains of powdered lactated calcium This dosage is for adults and is used in proportion to age for children Glasses with polarized lens and calabar lens seem to give better results for photophobia than ordinary colored lens It must be kept in mind that these are palliative, symptomatic measures and a search should be instituted for all the offending allergens, pollens, foods, and dusts

The allergic method of treatment may include dry therapy, the avoidance of the etiological factors, the eradicating of some therapeutic infection, or the application of a non-specific therapy. Any one, or a combination of these various types of therapy, may be required to obtain results

#### SUMMARY

From the review of the literature and my personal experience in this field, it seems certain that allergies play a very definite rôle in ophthalmology.

Most cases of vernal catarrh occur in children When the age of puberty is reached symptoms of vernal catarrh usually disappear and it is at this time that we have an entire change in the endocrine system of the child Unfortunately, there is no accurate means of determining the function of most of the glands of internal secretion and knowledge of the normal biochemical disturbances is so limited that in most cases it is impossible to come to a definite conclusion.

It would seem that the endocrine balance, with metabolic and biochemical function disturbances, is closely associated or the underlying cause of the allergic manifestations. Allergic patients improve rapidly when endocrines are given with the desensitization process

#### CONCLUSIONS

1. Allergy plays an important rôle in ophthalmic entities.
2. Endocrine disturbances are usually present with allergic phenomena.
3. Endocrine therapy helps the allergic patient
4. The factors of endocrine balance, metabolic and biochemical functions, vitamins, and heredity, all play a part in the allergic patient's manifestations

I wish to express my thanks to Drs. French K. Hansel, Albert Lemoine and John L. Meyers, for their invaluable assistance in compiling this paper

#### REFERENCES

1. APRTHUS, N. M. Injectous repeteis de serum de cheval chez le lapin. *Compt. rend. Soc. de biol.* 1923, 55, 817
2. ELSCHNIG, A. Studien zur sympathischen Ophthalmie II. Die antigene Wirkung des Augenpigmente. *Arch. Ophth.* 1910, 76, 592
3. GIBSON, W. S. The etiology of phlyctenular conjunctivitis. *Am. J. Dis. Child.* 1918, p. 188
4. GIFFORD, S. R., and STEINBERG, A. A. Allergic and toxic properties of lens protein. *J. Am. M. Ass.* 1925, 85, 351
5. HANSEL, FRENCH K. Allergy of the Nose and Paranasal Sinuses. St. Louis: C. V. Mosby Company, 1936
6. LEMOINE, ALBERT N. Conjunctivitis and dermatitis due to butyn. *Am. J. Ophth.* 1927, 10, 2
7. LAGRANGE, H. Conjunctivitis of anaphylactic origin. *Presse méd.* 1923, 31, 380
8. LEHRFELD, LOUIS. Recent advances in vernal conjunctivitis. *J. Med. Soc. N. Jersey*, 1937, 34, 731
9. MAGENDIE. Ehrlich's Gesammelte Arbeiten. P. 332. New York: John Wiley & Sons, 1906
10. SCHOENBERG, M. J. A contribution to the experimental study of ocular anaphylaxis. *New York State J. Med.* 1914, 14, 493
11. UHLENHUTH, P. Zur Lehre von der Unterscheidung verschiedener Eiweissarten mit Hilfe spezifische Sera. *Koch's Festschr.* 1923, p. 49
12. VERHOEFF and LEMOINE. Endophthalmitis Phacoanaphylactica
13. Idem. Hypersensitiveness to lens protein. *Am. J. Ophth.* 9, 5, 1922
14. WALKER, I. C. Personal communication. *J. Med. Research*, 1917, 37, 51
15. WESSELY, K. WEBER. Anaphylaktische Erscheinungen an der Hornhaut. *Muenchen med. Wchnschr.* 1911, 58, 1713
16. WOODS, A. C. The application of immunology to ophthalmology. *Arch. Ophth.* 1932, 53, 4

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present in the lacrimal sac or canal, one should consider the possibility of hypersecretion of the tears as a cause for epiphora before attacking the puncta or canaliculi. This can be demonstrated by the Schirmer blotting paper test, other individuals being used as controls, and if the output of the lacrimal gland is definitely increased, one can treat the gland with x-ray, excise the accessory lobe of the lacrimal gland, section the ductules, or inject the sphenopalatine ganglion.

If stenosis of the lacrimal sac or canal is demonstrated by x-ray, some procedure to restore normal function of the drainage apparatus is indicated. Various techniques to accomplish this end have been devised. Many were discarded and later revived to good effect. In the main the acceptable methods may be listed as (1) The external operation, in which an anastomosis with sutures is made through a skin incision between the lacrimal sac and the nasal mucosa, (2) the internal, whereby an opening into the sac is effected from within the nasal cavity, (3) the combined operation of Toti-Mosher, in which the surgical attack is from both outside and inside; (4) the transplantation operation, whereby the sac is lifted from its bed through an external incision and transplanted through a new bony opening into the nose, and (5) giant probing, in which an opening is forced from the sac to the inferior or middle meatus and a drain is left in place.

*External operation* The external operation dates from the early part of the eighteenth century when an English surgeon, Woolhouse, reported a technique which was later revived in 1904 by Toti and has since been popularized by Depuy-Dutemps and Bourguet. Chandler, in his comprehensive review of this subject, states that it is the most refined of all operations on the lacrimal sac and ranks first in the statistics on successful results.

It is the procedure with which my associates and I are most familiar, and in our hands it has been successful in 27 consecutive operations. These have been done on 24 patients ranging in age from 6 to 72 years. Six operations followed acute attacks of dacryocystitis at intervals of 1 to 6 months with no untoward reaction. Fistulas, which were present in 3

cases before operation, gave no further trouble afterward. One operation was done on a patient with congenital syphilis who also had a perforation of the septum. One young female patient had an obliteration of the lacrimal fossa following an automobile accident, which destroyed the bridge of her nose and necessitated many plastic operations for its restoration, the result in her case was as perfect as the others. A middle-aged male patient lost his right eye and suffered mutilation of his face following a shot gun accident, and the atrophied tear sac was located in a mass of scar tissue a full centimeter from its natural bed in the lacrimal fossa. Although the sac was reduced to the size of a pea, it was possible by traction sutures to make an anastomosis with the nasal mucous membrane and this also resulted successfully.

In one patient only have we been disturbed by the formation of a scar. This was in one of our early cases, a middle aged female of Grecian lineage, who developed a keloid type of bridge scar, which we later attempted to improve by plastic repair but with which we were never quite satisfied. In checking the final results of our limited series we were greatly surprised to find that this patient's answer was the most enthusiastic of all; she was perfectly satisfied with the physiological and cosmetic result.

Many operators with much more clinical material have found this procedure satisfactory in from 95 to 100 per cent of cases. Inasmuch as this is an operation which the ophthalmologist without special training or apparatus can learn to do satisfactorily from the diagrams and description, the technique will be given in some detail here, and the student is referred further to the excellent article by J. J. Corbett. It was this article which induced us to adopt the procedure which in our hands has been quite satisfactory.

#### OPERATIVE TECHNIQUE

Anesthesia is obtained by the hypodermic injection, approximately one hour before operation, of morphine one-half grain to one-eighth grain and scopolamine, one hundredth to one four-hundredth grain, depending on the age and size of the patient.

## THE PRESENT STATUS OF SURGERY OF THE LACRIMAL SAC

RALPH O RYCHENI R, M D, F A C S, Memphis, Tennessee

THE patient with chronic dacryocystitis, presenting clinically an epiphora and regurgitation of mucopurulent secretion into the conjunctival cul de sac, brings to the ophthalmologist a condition which is of decided interest and importance. The constant watering of the eye is most annoying and prevents comfortable and ordinary use of the eye at any time, while the integrity of the eyeball is in constant jeopardy as the smallest abrasion, such as follows a foreign body in the cornea, may result in infection, ulceration, and loss of the eye.

This type of inflammation has resulted in a variety of procedures designed by radical means to eliminate the focus of infection in the tear sac, such as chemical destruction by cauterization, excochleation, Paquelin or galvanic cautery, and finally excision or extirpation. All of these procedures have had ardent advocates and have been successful in eliminating the backwash of purulent material into the conjunctival sac, but they have been notoriously unsuccessful in ridding the patient of his epiphora which is the main symptom for which he seeks relief. Statistics from various competent clinicians demonstrate that epiphora persists in as many as 65 to 70 per cent of patients who have had the tear sacs removed, and that nearly as high a percentage of patients are dissatisfied with the results of operation.

The so called medical treatment of lacrimal stenosis by the passage of probes to the nose through the normal passages of the lacrimal drainage apparatus has in general given only temporary relief. One may be elated at one sitting to find that relatively large probes can be passed through the stenosed areas after which fluids pass easily into the nose, only to find at the next visit of the patient that a subsequent reaction has produced a constric-

tion that does not permit the passage of even the smallest probe without considerable trauma and bleeding. This in effect influences the formation of false passages, scar tissue proliferation, and increased stenosis with considerable discomfort to the patient and, as a rule, leaves him with no permanent benefit.

These experiences have caused most of us to seek some method of re establishing normal communication between the conjunctival sac and the nose by means of some operative procedure which promises a permanent and successful result. Such a result is one in which epiphora and mucopurulent secretion from the lacrimal sac have been eliminated entirely, and in which the patency of the drainage system can be demonstrated by the passage of fluorescein or some similar colored solution from the surface of the conjunctiva to the meatal area in the nose. It is not enough to force fluid to the nose by means of a syringe, the fluid should travel as do the tears in a natural unaided way. To obtain this end it is essential that the puncta, canaliculi, and internal common punctum be left in a perfectly normal condition, for if the capillary attraction of this portion of the drainage mechanism is disturbed, one is doomed to disappointment in proceeding to operate on the sac itself. There has been heretofore too widespread an attack upon the puncta and canaliculi by means of slitting and excision when the pathology really lay more deeply in the depths of the sac and lacrimal canal.

These mistakes need be made no longer as the use of a radio-opaque medium such as lipiodol, bismuth in albolene, or iodipin, injected into the lacrimal sac will by x ray demonstrate the position of any stenosis in the passageway. The first is an excellent solution but the injection should be made on the x ray table as lipiodol passes through the lacrimal sac rather rapidly. If no stenosis is

Postoperative treatment has rarely been necessary although occasionally some crusts will have to be removed from the nose. In our series of 27 cases we have had but one postoperative hemorrhage which required packing the nose, and the nasal pack in this patient was removed the morning following the operation with no further complication. On only 2 occasions have accessory ethmoid cells been encountered. These were exenterated and the operation was carried out in the usual manner without complication. In no case as yet have we found it necessary to remove the anterior tip of the middle turbinate or operate on a deflected septum, although we recognize that in some patients there will be nasal pathological processes which require preoperative treatment or surgery. In 1 patient, previously operated upon elsewhere by the combined method, it was necessary to remove by cauterization an adhesion between the septum and the middle meatus.

Paul Chandler has recently advocated a modification in this operation by preparing 3 mucous membrane flaps instead of 2. He made an incision in the tear sac in the form of a T, with the horizontal incision about 3 millimeters from the upper border extending from the anterior to the posterior edge of the sac. The vertical cut extended from the center of the horizontal incision down to the base of the sac, and as far into the duct as possible. A similar incision was then made in the nasal mucous membrane exactly opposite the sac. Thus 3 flaps were formed, a posterior, a superior, and an anterior. These he united with small silk sutures, usually 1 posterior, 2 superior, and 1 anterior, resulting in an almost solid tunnel of mucous membrane running from the sac to the nasal cavity, and the top of the sac was held up in its proper position. Twenty-two operations which he performed in this manner were all successful.

*Internal operation* The first report of an operation by the intranasal route was by Caldwell in 1893. The method has been extensively advocated by West who made a large opening into the duct above the inferior turbinate and then later modified it to uncover the entire lacrimal sac without opening the duct. Various other modifications in the mat-

ter of reflection of mucous membrane flaps have been followed by good reports from Halle, Bookwalter, Daily, and others. This operation can be done with satisfaction but presents considerable technical difficulty if properly done. It falls in the class of operations which demand a high degree of intranasal technical skill, the only excuse for which is that no external incision is made. It is not an operation for an ophthalmologist, and many prominent rhinologists feel that it is not as safe a method as the one previously described. Perforation of the orbital wall with cellulitis of the orbit and loss of visual acuity has been reported.

*Combined operation* The combined operation comprised the external technique of Toti with some intranasal modifications of Moshé, which included the removal of the anterior tip of the middle turbinate and curettage of the anterior ethmoid cells in all cases. In addition, any deviation of the septum was corrected by preliminary operation.

A bony window was made through the lacrimal fossa, the exposed nasal mucous membrane excised, and a similar area cut from the approximating wall of the lacrimal sac. The anterior edge of the sac was sutured to the cut edge of the periosteum over the nasal bone but there were no sutures connecting the nasal mucous membrane with that of the sac.

Failures were common because of poor approximation of the openings in the sac and nasal mucous membrane, closure of the osteotomy, or plugging of the newly formed opening by granulations. Successful results ranging from 40 to 100 per cent have been reported.

*Transplantation* The transplantation method was devised by Forsmark who lifted the lower part of the sac from its bed, severed it at the duct, and then drew the end of the sac into the nose through a small opening in the lacrimal bone. This was modified by Speciale-Cirincione who made the bony window through the anterior lacrimal crest, thereby avoiding the ethmoid cells. This has lately been revived by Stokes who shortened the time of the operation by using an electric trephine which drilled a hole through the ascending process of the maxilla. Stokes re-

Block anesthesia with 1 per cent solution of novocain with adrenalin is made over the supra orbital, anterior ethmoidal, and infra orbital areas as well as in the line of incision and deeply in the bed of the sac.

A cotton or gauze plug saturated in 10 per cent solution of cocaine and adrenalin, 1:1000, is inserted in the middle meatus of the nose near the anterior tip of the middle turbinate in order to produce anesthesia and ischemia of the nasal mucous membrane, and is left in place until the nasal mucous membrane is exposed by removal of the lacrimal crest.

Illumination of the field of operation is an important factor and I use an electric head lamp for this purpose, although a concave head mirror with a good source of light is sufficient. Bleeding is controlled by the suction tip, a point which has been a great aid in shortening the time of operation.

The skin incision is that commonly used in most external sac operations, starting about 5 millimeters above the internal palpebral ligament passing down over its bony insertion (about 5 millimeters to the inside of the inner canthus) in a line parallel to the lacrimal crest, and terminating at a point opposite the entrance of the nasolacrimal canal.

The internal palpebral ligament is cut, the superficial fascia, muscle, and deep fascia are divided, and the sac exposed and reflected outward as it is lifted out of its bony groove. The sac may be retained in this position by means of a retractor, while a similar retractor holds the structures on the opposite side of the wound well over toward the median line. The retractors are held by one assistant while the other assistant works in the field with the operator. I have found that the use of the ordinary lacrimal sac retractor will obviate the necessity for one assistant if the retractor prongs are entered more deeply into the wound and allowed to engage the subcutaneous tissue just over the sac wall and just above the periosteum of the anterior lacrimal crest.

The next step is the complete removal of the anterior lacrimal crest by means of a chisel. When the nasal mucous membrane is exposed the bony opening is enlarged with Citelli and Kerrison forceps, making an oval

shaped window with the long axis from 10 to 12 millimeters in the vertical plane while the transverse diameter varies from 8 to 10 millimeters. Lately, Arruga has advocated making the opening with a motor-driven trephine. However, the technical difficulties encountered at times with such an instrument are considerable and I have not been impressed with it in my personal experience.

At this stage a longitudinal incision is made in the wall of the sac. The pus or mucus, if present, is removed, and the inner lining of the sac is swabbed with tincture of iodine. The nasal plug is then removed. A vertical incision is made in the nasal mucous membrane, equal in length and directly opposite the sac incision. Three sutures of No. 0000 catgut on small half curved atraumatic needles are passed by means of a small artery forceps through the posterior tip of the nasal mucous membrane.

These 3 sutures are held taut while a cut 2 millimeters long is made at right angles to the upper and to the lower end of the vertical incision. This forms a flap which facilitates approximation to the posterior lip of the sac. The 3 sutures are drawn through the posterior lip of the sac incision by the small artery forceps tied, and cut close. Thus the posterior wall of the new lacrimal drainage canal is formed.

After the same fashion 3 more No. 0000 catgut sutures are passed through the anterior lip of the nasal mucous membrane with the same forceps and held taut while the right angle cuts similar to those in the posterior lip are made. These sutures are drawn through the anterior border of the sac and in addition through the periosteum and overlying soft tissues. The sutures are then carefully tied. It is this last little feature of the Dupuy Dutemps technique—the suspension of the anterior wall of the canal from the overlying tissue—which aids in maintaining the patency of the new lacrimal canal. Three silk sutures or a subcuticular suture closes the skin incision. An ordinary eye bandage is applied but there is no intranasal dressing. Sutures are removed on the third day and the bandage is discontinued thereafter. The patient leaves the hospital on the second day.

# THE 1938 CLINICAL CONGRESS

## THE AMERICAN COLLEGE OF SURGEONS IN RETROSPECT AND PROSPECT ON ITS TWENTY-FIFTH ANNIVERSARY

FREDERIC A. BESLEY, M.D., F.A.C.S., Waukegan, Illinois

THIS, the twenty-fifth anniversary of the founding of the American College of Surgeons, is a milestone in its progress. Let us review the accomplishments of its first quarter of a century. Have the years of planning and of laboring to uplift the standards of surgery produced results? In what directions has the influence of the College been strongly and courageously wielded? In what other directions could that influence have been more powerful, more beneficial, more significant, had our vision been clearer and our convictions stronger?

This is a time for critical self-analysis by the Fellows of the College. We are starting on a new stretch of our journey. We have an opportunity to re-define our objectives and to re-intensify our efforts in the directions in which we appear to be pursuing the right course. Today is the future of which some of us had a vision 25 years ago. The realities around us now are the fulfillment of those dreams of yesterday. In all respects they do not meet our expectations, but not one of us will question that without the dreams the realities would have been far less satisfying. Therefore, we must focus our eyes today on the next quarter of a century. We must dream and plan anew so that the record of the next 25 years' accomplishment, upon which the new generation of surgeons will look back in the year 1963, shall be equally as inspiring, and equally as substantial and impressive as the one we now review.

We have important advantages today over the dreamers of 1913. These are the results of their great foresight. We are solidly organized for smooth functioning. We have

accumulated experience in co-operative effort which gives us confidence. We have acquired a background, a sense of stability, and a feeling of permanence that equip us for accomplishing much more in the future than we have in the past. We have won in the eyes of the profession and of the public a position of unquestioned leadership in our field. This last achievement compels us, as trusted guardians of the sick and injured, to insist that surgeons be guided by the highest professional and ethical considerations. Upon us devolve responsibilities not for our own fellowship alone, but for all members of the profession. Looking to the future, we see no lessening of responsibilities. Rather, as our ideals and our purposes become more widely understood, we see increasing dependence upon the College, by both the profession and the laity.

Our founder and organizer, Franklin H. Martin, set us an example of courage and of persistence that is a wellspring of inspiration. Consider the obstacles he faced in trying to weld a profession, composed of individualists, into a guild organized to curb unethical practices by individuals, and to encourage a co-operative ideal that would necessarily destroy individualism of the old, self-sufficient type. The College stands as a living monument to his success in overcoming these obstacles. He took the spirit of democracy and the spirit of co-operation as ingredients, and mixed a potion strange to the taste of the average surgeon of his day. Many of them drank reluctantly. But time and circumstances, and his own gifts of diplomacy and persuasiveness, were on the side of Dr. Martin, and those surgeons learned to like the potion as they felt its stimulating effects.

In organizing the College Dr. Martin and his associates followed the principles of demo-

Address of the Retiring President, presented before the Clinical Congress of the American College of Surgeons, New York, October 17-21, 1938.



ported very favorably on a series of 43 cases. Patency of the sac is essential and the constriction must not be present above the point of severance else the result will be a failure. It will be an excellent operation for cases of chronic dacryocystitis in which a mucocele is present, but will not serve when the sac is atrophic, when papillomas are present or when the sac wall is involved.

**Giant probing.** Under giant probings are grouped all methods by which a probe is forced into the nasal cavity, either through the original duct passageway or through a new opening in the lacrimal bone, following which some metallic stylet is left in place for varying periods of time. Such operations were suggested by Koster, Ziegler, Fowler, Dean, and others. Probably the best procedure along these lines is that reported by Spratt who slit the lower punctum and under gas anesthesia introduced a Callahan tube on an obturator through the lacrimal passage. The obturator was withdrawn leaving the thin silver tube open at each end, the lower end under the inferior turbinate and the upper end flush with the conjunctival cul de sac. This may be left in place for months and extracted when desired by grasping the lower end with a hemostat and withdrawing it by a rotating movement which crushes the thin silver tube and permits painless removal. Success with this instrumentation has been high.

From the statistical reports available on the operations heretofore described it seems certain that some form of dacryorhinostomy should be substituted for the operation of excision or extirpation of the sac in cases of chronic dacryocystitis. This latter operation should be reserved for tumors of the lacrimal sac and to my mind, that condition should be almost the sole reason for its application. In this connection one should be on guard not to mistake for tumor of the sac the hard unyielding mucocele sometimes encountered in stenosis of the duct. In our series of 24 patients, there were 5 who some time during their treatment were suspected by my colleagues and myself of having malignancies of the sac. The instillation of saline into the sac, the application of heat externally and persistent massage over the mucocele finally re-

sulted in the discharge of a viscous, glairy fluid from the sac through the canaliculi on the conjunctival surface.

It may be justifiable to extirpate the sac previous to intra ocular surgery, when one is pressed for time, but one may be lulled into a feeling of false security by doing so. Virulent cultures of pneumococci have been grown from the conjunctival cul de sac for weeks after such an excision, and it is justly questionable whether dacryorhinostomy is not the choice of procedure even in this situation.

#### SUMMARY

The purpose of this paper has been to review briefly the various methods to bring about a favorable solution of the intractable problem of chronic dacryocystitis. Results will vary with various operators and each will continue to use the method which has done well in his hands. But for those who have not been successful in treating this condition and for those who still do extirpation in preference to some form of dacryorhinostomy, I offer the choice of several techniques any one of which has its good points. For the beginner in this field of surgery, the external operation with sutures, which join the mucous membranes of the sac and the nose, will prove to be quite satisfactory. Once he has mastered this technique he may proceed to modifications, but one hesitates to change the form of surgical procedure which has given uniformly satisfactory results in his hands, hence I believe that most new converts will continue to use it.

#### BIBLIOGRAPHY

1. ARBUGA. *Ann d'ocul.* 1920, 166 580
2. ASHCUR. *Tr Am Acad Ophth & Otol* 1927 p 55
3. BOOKWALTER. *Arch. Ophth.* 1930 49 503.
4. CHANDLER. *Tr Am Ophth Soc* 1930 36 240
5. CORBETT. *Am J Ophth* 1928 21 774
6. DAILY AND DAILY. *Am J Ophth* 1929 12 1
7. DEPUY DUTEMPS. *Ann d'ocul* 1921 158 241
8. ELLETT AND RUCKENBER. *South. M J* 27 339
9. FÖRRE. *Sitzungsber Ver d Schwed Augenuerztall* Stockholm, 1917
10. GIFFORD. *Ophth Rec* 1909 18 454
11. MACMILLAN. *Arch. Ophth* 1932 8 831
12. MOSHER. *Laryngoscope* 1915 25 739
13. SPECIALE. *LARINGOSCOPE Clin ocul* 1913 13 1369
14. STOKES. *Nebraska State M J* 1935
15. TÖRL. *Ztschr f Aug nh* 1912 27 115
16. WEEKS. *Arch Ophth* 1932 7 443
17. WEST. *Tr Am. Ophth Soc* 13 654

nenced, highly trained men have worked diligently to secure first-hand, accurate information of many kinds from many sources. Their findings have influenced the determination of policies by the Board of Regents, and the execution of these policies by the administrative executives. The proficiency of these investigators is increasing. In the future it will doubtless be necessary to increase their number as the scope of the College activities broadens to include new avenues of service. It can be stated with some degree of finality that this branch of the College work will grow and become more vital.

Another activity that has bright prospects for continued growth is the Library and Department of Literary Research. A valuable service, constantly improving, is being rendered. The usefulness of the package library service cannot be overstated. In the future the service of the library will be utilized and appreciated even more. By co-operating in securing additions to its collections, the individual Fellow can help to increase the department's ability to serve the fellowship.

The College has used the congress and conference method extensively for educating the profession and the layman. While this work is not handled in a specific department but is participated in by all departments, it is an established activity that, for our purposes today, needs separate consideration. It is an activity that has reached astonishing proportions. The Clinical Congress of the American College of Surgeons is one of the great educational events of the year on this continent. Few regular occurrences of any nature are accorded more attention by the press. This shows that the College has been able, with the co-operation of the press, to arouse a demand for news of advances in surgery. When to this public educational value is added the instructional value to the surgeon himself, it is safe to prophesy that the annual Clinical Congress will have a brilliant future to correspond with its brilliant past.

The miniature clinical congresses, or Sectional Meetings, the idea of which was conceived 20 years ago, have performed in their lesser spheres the same service as the larger congress and have the same outlook for con-

tinued success. The first was held in Butte, Montana, the beginning of a series of meetings which have introduced the College and its work to the American people in their home communities. In the smaller group more discussion and freer expression are possible, and the scientific sessions and operative clinics held in the smaller cities have been valuable supplements to the Clinical Congresses held in the larger cities. The community health meetings, for obvious reasons, have been particularly well attended in the smaller communities, and have unquestionably stimulated confidence in the doctor. Confidence, so engendered, will help the public to seek medical advice more frequently and follow it more intelligently. The public should not be expected to accept medical practices on faith. There is nothing occult or mysterious about modern medicine, its scientific basis should be made more clear to the layman to help him to distinguish between impostors and competent doctors, and between haphazard and correct procedures.

This introduces the subject of public education which cannot be too strongly emphasized as a field which must be cultivated more systematically by the medical profession. The College has already prepared the ground in a more or less incidental fashion through Clinical Congresses, Sectional Meetings, and the publicity arising naturally as a result of its various activities, especially Hospital Standardization. The community health meetings have provided an excellent impetus. However, more of a direct nature must be done. The practice of medicine has never been so prominent in the day's news as it is now. Back of it is a gradual awareness by the public that great things have been occurring in the field of medical science, an awareness that we ourselves have tried to develop; and people want to know more about the new discoveries, the new theories, and the new procedures. They also want to know why they are not all benefiting from these discoveries as they should.

Capitalizing upon this interest, authors and publishers are turning out books and articles that are being read avidly. And what is in them? Much sensation and distortion of facts, merely to enhance their readability and

cratic rule, distributing the executive power among many individuals through a representative Board of Governors and a Board of Regents who would be free from any direct self interest or monetary gain. Thus they assured adaptability and the constant influx of new ideas. The basic principles involved in the welfare of the patient will not change, but the modes of applying these principles are changing constantly with new conditions.

As an illustration, there has arisen of late the important question of graduate training in general surgery and its allied specialties. The College has always been actively interested in the formal education and early training of the surgeon. But lately surgery has been tremendously complicated theoretically and practically by new discoveries, new methods, and modern developments in technique. To obtain the desirable command of knowledge and the necessary skill for precision and safety, the student of surgery today must add a more supervised training to his clinical preparation. Not enough qualified hospitals however are providing opportunities for him to gain such practice. Therefore, the College is assuming the responsibility, which rightly belongs to it to determine the extent of the need and to encourage hospitals to inaugurate a graduate training program in surgery, or to enlarge and improve the one they may have at present. The Board of Regents of the College, by raising the requirements for admission to fellowship for this and succeeding years' graduates, obligated our organization to aid in providing opportunities for the extended training that these higher standards demand.

The established departmental activities of the College since they were carefully based on pressing needs for reform or for research, have produced actual tangible improvements in surgical and hospital methods and environment. Perhaps we should consider whether any of these departments have accomplished the purposes for which they were founded to such a degree that their task is finished. Must the College ever be seeking new avenues of service, or does the future hold boundless opportunities for some of these established departments?

The Department of Hospital Standardization—one of our strongest divisions of endeavor, the achievements of which are so well known that they need no reiteration before this audience—what will be its future? Hospitals, like the human beings who work in them, betray no signs of reaching a state of perfection, despite our energetic efforts to improve them. This is an admission we must make at the outset. It means that the work of the hospital department of the College will never be finished. Changing times will bring only new problems. The department must co operate with the Committee on Graduate Training by continuing to survey, analyze, and plan for the developing of graduate training opportunities in acceptable hospitals. In assuming this responsibility the department is insuring its own happy destiny by multiplying its opportunities for present and future service to the patient in the hospital.

The Department of Clinical Research has likewise made rapid progress and insured its permanent usefulness by seeking and making the most of opportunities for service. Great educational and practical benefits have resulted from the promotion and surveys of cancer clinics, the registry of bone sarcoma, the collection of records on 5 year cancer cures, the surveys and standardizations of medical departments in industry, and the efforts to improve the management of fractures. The Fellows of the College are essentially practical, realistic, clinically minded surgeons and in the future they will be guided more and more by the evaluations of advances made in clinical surgery as presented by the Department of Clinical Research. In the past 4 decades much of the advance in surgical therapy has been in the technique of operating, and it may be predicted that in the future increasing study and research will be devoted to the cause, pathology and progress of those diseases which are now and will later be found to be amenable to surgical treatment. The Department has before it an ever widening horizon of usefulness and influence in contributing to the advance of scientific surgery.

The field representatives of the College deserve special acknowledgment for the surpassing value of their services. These expe-

ments participate. Its program has been actuated by a desire to enable the surgeon to play in this joint effort the important part for which his background and services qualify him so that the effort as a whole may be more effective. All plans of the College for the future are being made in this same co-operative spirit.

As for the science of surgery, the College has an ambitious project which typifies its zeal to spread knowledge. This refers to the Hall of the Art and Science of Surgery. As yet there is no distinct building in which to house it, but a site has been acquired on which to build some day, and we dreamers of 1938 see upon it, not the old structure that now stands there, but a fitting monument to the inspiration and zeal of those who have led in the research work of the College. Nor is the project wholly dependent upon imagination for sustenance. An impressive nucleus for the collection of exhibits already exists. It is well arranged for display and bids fair in the not too distant future to outgrow the accommodations for its exhibition in the Administrative Building. The Hall of the Art and Science of Surgery will some day need a building of its own, and many of us, we hope, will live to see it rise.

Chiefly, it is as a moral rather than a material force that we see the College of the future. Our ambition for it is that the quality in which it shall most excel will be that of worthy leadership. It needs no artful phraseology or extensive logic to point out that there is grave need for medical statesmen in the ranks of organized medicine. Men who have a broad vision, and the diplomatic and judicial qualifications which make for leadership, are required to cope with the difficult problems confronting them, which cannot be regarded with indifference and equanimity. It is the

duty of the American College of Surgeons to discover and to develop leaders who will make the influence of the profession felt in improving the whole environment of human life. A large part of that responsibility is distinctly medical, for a high average of health is essential to progress. We in the medical profession are compelled today, for our own good and for the good of society, to pool our problems with those of other social agencies, to the end that the fundamental factor of adequate medical care be a strong impetus to their constructive efforts. We must maintain a flexible mentality. Good health fosters economic self sufficiency, good citizenship, everything that makes a happy life. Therefore, it is our duty to welcome and not to resent the interest being shown in high places in the conduct of medical affairs, it shows appreciation of the importance of the work we are doing and can do. As an organization of surgeons we have before us a great opportunity to throw our experience and our intimate knowledge of the problems back of any effort to provide better care for the patient, with the insistence that the direction of the effort be placed in the hands of a competent medical personnel.

If we make the most of our present opportunities, we face a busy, eventful, new quarter of a century. That is what we want—is it not?—strenuous working programs ahead to call forth our best efforts, to develop us individually and as a strong fellowship striving to serve our generation. The College was erected on an ideal for service, so far we think we have lived up to that ideal to the best of our collective abilities. The prospect is that we shall continue to go forward by holding to that ideal. Hopefully and optimistically we set forth on our new quarter of a century for “it is better to journey hopefully than to arrive.”

increase their selling power. Some of the current, popularized, medical literature is good and is truly educational, but much of it exaggerates the flaws which we all know exist, while it fails to convey the impression it should of the sound features of modern medical practice. As is always the case in such a situation, the attack is read by 10 persons and only 1 will read the answering defense if the profession is sufficiently aroused to prepare one for publication. The result is that we may expect a weakening of public confidence unless direct measures are taken to interpret the doctor aright. When the profession is misrepresented as being more interested in its economic security than in healing the sick, the remedy is to let people know in a more systematic way than we have heretofore attempted, that we are surgeons first and earners afterward, for this is true of the great majority of members of the profession.

This brings us to a consideration of the unfortunate practice of fee splitting which furnishes the public with one reason for the accusation of commercialism. Fee splitting is diminishing, we believe, but it is still quite prevalent. The College has fought it from the beginning. Candidates must sign a pledge not to indulge in it, hospitals in which it is countenanced are not approved, and other professional groups have likewise acted against it. In some instances the agitation has only degraded an open practice to a surreptitious one, so more stringent measures are needed to abolish it completely. The competent physician should have a high enough estimate of his own worth to convince his patient of the value of his services and should not expect what amounts to commission on a sale deducted from the surgical fee. Such a practice endangers the patient because it fosters bargaining, and the only way in which it can be completely eradicated is to educate the public to its evils. The Board of Regents of the College have done much to decrease the practice of fee splitting. It is their clear and pressing duty to eliminate it altogether.

The doctor is handicapped because he can not advertise his honesty, his philanthropy, or his spirit of service the way a man who operates a business can, and so the critics are

unanswered when they point to a practice such as fee splitting, which is really indulged in by only a small minority. Consequently, the medical profession has to use extraordinary measures to regulate the unethical minority, in order that aspersions may not be cast through them upon the entire membership. Through its own organizations such as the American College of Surgeons it has provided for self policing, as well as for the developing of programs for broader and constantly improving service to the patient. To acquaint the public with the work the College is doing is to enlighten it concerning the scientific, humanitarian, and public service attitude that characterizes the typical surgeon who through his fellowship and support decides the scope of its activities.

It is true that the great advance shown by medicine, scientifically speaking, has not been quite equalled by medical practice as applied to the needs of all classes of society. This problem, however, is not by any means peculiar to the medical field. It exists in government, in industry, and in education. The progress that has been made in improving the lot of the individual is generally obscured by the far greater progress in theoretical and factual knowledge in almost any field. A parallel can be drawn between this state of affairs and the noticeable lag between almost any man's actions and his professed principles and ideals. We think that the medical profession is trying as hard as any other and perhaps harder than most, to solve the problems arising out of uneven distribution of income which makes its services easily available to a few people, but not obtainable by the great majority in the lower income brackets. It is unquestionably a fact that physicians and surgeons give more service for which they receive no money compensation than any other class of people in modern life, and they give it gladly because of the humanitarian motives that govern them.

The American College of Surgeons has always recognized the advantage of united effort by all groups acting to improve the care of the sick and injured and to promote preventive medicine. This again might be considered a special activity in which all depart

And the truth is the surgical world had great need of such a mandate. May I place before you, very shortly, the proof of this, the setting of that earlier time.

Though the American Medical Association had been founded in 1847 for the betterment of medical education and the control of irregular practice, very little was achieved until in 1904 it appointed a special council for the study of this Medical Education and Hospitals. At that time there were in this Country, 162 medical schools, more than in all the rest of the world put together. And is it any wonder that Henry S. Pritchett, president of the Carnegie Foundation said of these schools, that nearly half were entirely inadequate, and Abraham Flexner declared that our "Medical education includes something of what is best, and all of what is worst, to be found among civilized nations."

And during those years surgery, perhaps, was the greater offender. For brilliant as were many of its exponents, the general standards were low, the prevailing methods slap-dash and ill informed with no general oversight or organization.

Samuel Gross of Philadelphia had published the first complete *System of Surgery* in 1859. Writing in 1876 he declared that "there is not a medical man on this Continent who devotes himself exclusively to the practice of surgery." This was the year, (1876), of the Founding of the American Gynecological Society. It was not until 1880 that the American Surgical Association was formed, and only in 1903 the Society of Clinical Surgery.

As an illuminating corollary we observe that in 1873 there were only 149 hospitals in these United States. In 1934, 61 years later, the number is given as 6,334, with their own hospital association formed in 1899.

This addition of 95 hospitals a year was merely the result of supply and demand, for there developed an enormous increase in the work of general surgery and its specialties, with the rapid creation of sixteen special surgical societies or associations. In all conscience it was rapid—really catching, like the measles. These sixteen societies, however, were separate and distinct, determined in part by the points of the compass, and in part by

the special character of the work. Separate and distinct I say, there was little dealing with one's neighbor, for there was as yet, no common nexus between them. You must forgive these facts and figures for it is only in this way that we gain a true perspective, realize the difficulties that beset us. Assuredly there was a large and disjointed house to be set in order—in Flexner's phrase, "something of what is best,"—and at the beginning of the century abundant need of our college mandate. *Vere scribere est per causas scribere*—to write truthfully is to write in the light of the causes of things. So in 1913, the stage was set.

Two ways were open to us—either to follow tradition and exact a scholastic examination, again an exclusive hierarchy, or on the other hand to create from the beginning a surgical commonwealth, the members to be chosen for their character, actual work, and experience.

I shall always believe that, very fortunately, our young College chose the latter course. For in so doing it drew together the many surgical associations, gave them an axis as it were, and also secured the influence and the weight of the whole profession.

After all, in any arena a "punch" is the thing that counts, and the mandate to impress itself, must have this general strength behind it. Moreover as we all know, an academic distinction may confer no skill in practice, even the author of a surgical text may be, as a surgeon, just a weariness to the flesh.

I make no apology for the early College requirement. Accordingly in the first 2 years we admitted to Fellowship 2,024, established at once a powerful nucleus, to control as it were, our cellular life. Speaking for the College we have had, as yet, no cause to regret it.

Again in my judgment, our College gains no small measure of strength from its democratic form of government. As you know, 50 Governors are elected each year for a triennial term; 17 of these represent the 15 surgical societies, the Army, and the Navy, while 33 are chosen by the Fellows at large. I think you will agree that this makes for a fair, a strong, and cohesive organization.

And now concerning the mandate, how much have we done? What is the accounting of our stewardship?

# OUR COLLEGE MANDATE

## A Tribute to Allen B. Kanavel

WALTER CHIPMAN, M.D., F.R.C.S. (Ed), F.A.C.S., Montreal, Canada

ON May 5 our College celebrated its twenty-fifth year its quarter century of service in these two Americas. Very reasonably, I think that we may be proud of the achievement. However, "Wisdom is justified only of her children", or, in other words, this very success carries with it a commensurate increasing responsibility.

While we have already 12,700 of these children, a large fellowship, mere numbers or mere size may be, in and of itself, no special virtue. Quality is the thing that counts, and a set regard for our abiding fitness in this changing world. And it is of this aspect of our college life that I shall speak.

You will remember that our Charter of Incorporation, in somewhat quaint phrase extends 'To All To Whom These Presents Shall Come Greeting'. And to this the 450 Founders annexed our constitution and our by laws bequeathed to us this College mandate. And we Fellows implement this mandate, give our hand upon it (as the name implies,) accept this trust, the privilege, the authority, and the obligation. For as a College we solemnly promise to do what we can for the betterment of surgery: its training and its practice, to improve our hospitals and our medical schools, to make of our College a great clearing house wherein a sound knowledge and a safe technique may be advanced, may be tested, stored, and distributed. It is indeed a reform from within, undertaken to make our surgical world a safer and a better place, the welfare of the patient, the alpha and the omega of it all.

And this is no small domain or no light undertaking. Even in our approved hospitals there are two and one half million operations every year, and how imperative is the need of a wise, a vigilant, and a critical stewardship. I need not say here that good surgery is a diffi-

cult, a responsible, and a painstaking business. To secure this for rich and poor alike is the purpose of this mandate, and it is the sum and substance of our College life.

Our College mandate then, and with a special reference to the life and work of the late Allen B. Kanavel, distinguished Regent.

And first in the name of the College, I extend an added welcome to the Class of '38—the 539 Fellows who have been admitted this evening. Oddly enough, your numbers are approximate to the number of our Founders—the Founders of this College. And our one wish is that you prove yourselves as good as they. This Fellowship confers a twofold blessing: you donate yourselves to our College life stream, a carefully matched transfusion, and in return, to each of you are thrown open the gates of a larger and more useful life.

Thucydides said of the ancient Greeks that they "possessed the power of thinking before they acted, and of acting too," and it is just this power of thinking and of acting that has set its seal upon this later Magna Graecia—our own America.

I can think of no better axiom to govern our College life, the *sine qua non* of any achievement. No one can gainsay that our Founders were men of thought and action. It is some time, said of Franklin Martin, that he dreamed three dreams and lived to make them all come true. And these three were: (a) the publication of the journal, SURGERY, GYNECOLOGY AND OBSTETRICS, in 1905; (b) the creation of the Clinical Congress of Surgeons of North America, in 1910; (c) the founding of the American College of Surgeons, in 1913.

The journal and the congress were the successive steps that led to the foundation of our College. How clearly it now appears to us! Franklin Martin, the great harbinger of our College mandate, now rests from his labors. We owe to him and his a debt we never can repay.

Oration on Surgery presented before the Clinical Congress of the American College of Surgeons, New York, October 17-21.

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The American Board of Surgery, established nearly 2 years ago, amply corroborates this undertaking. In this way then, we educate and train our future Fellows, and peradventure by so doing we may silence the criticism of, may even satisfy, the dyed-in-the-wool academic mandarin. In any case, we benefit ourselves in this appeasement.

Dr Richard C. Cabot, of Boston, recently observed that the greatest single curse in medicine is the curse of unnecessary operations. Well, the above is the remedy to lift this curse even from the mind of the austere physician, and in raising these standards, we are merely redeeming our promise, fulfilling the terms of our College mandate.

The strength of it all, of course, is derived from the individual fellow, his character, his education, and his work. To the extent of his sixpence, the success or failure of the College, is determined by each and every one of us. And just here how apposite is Carlyle's enunciation that, "what you are, thunders so loud I can't hear what you say."

May I quote to you the following: "The failure of any Fellow to conserve the ideals of professional honor, of service to the public, and of self-improvement, will impair more than we realize, the prestige of the College." Thus spoke Allen B. Kanavel in his presidential address here in this city, 7 years ago.

From the beginning, our College has been blessed with outstanding men, men who have guided its policy and given it impetus and inspiration. These have been our "prophets in Israel," and this Chicago surgeon was one of the latest and by no means the least, of these. We do well to learn from such men, to study their lives, their influence, and example.

Born in Kansas in 1874, Allen Buckner Kanavel was graduated from Northwestern University College of Liberal Arts, at the age of 22, and three years later he took there (cum laude), his medical degree. After 6 months of graduate study in Vienna, he returned to Chicago, serving first as an interne at the Cook County Hospital, before becoming associated with the department of surgery at Northwestern University Medical School. Here he was to

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Very early in his career he became impressed by the haphazard treatment of severe infections of the hand, and so he was led to undertake his famous dissections of the hand and forearm, using the injection of bismuth paste, to determine the relation of the tendon-sheaths, the lymphatic and fascial spaces—the natural channels of invasion. He was engaged on this work for some ten years, and in 1912 he published the monograph, *Infections of the Hand*, now in its seventh edition and a recognized authority throughout the world.

And this was only the beginning. The long list of his contributions to our surgical literature reveals a wide range of investigation and a continued interest in all research. In his practice he was perhaps best described as a specialist in many fields, equally at home in the axilla, head and neck, and the abdomen. His operative work was neat, resolute, and resourceful and Lord Moynihan was led to declare that in any serious operation upon himself, this surgeon was the man to do it. No mean tribute I can assure you! Moreover there were other qualities of the artist in him as expressed not only through his hands, but also by his unusual gift in writing and in speech. He was an admirable teacher, and an outstanding exponent in his chosen profession.

In the midst of this active professional life, Dr Kanavel found time, or made it, for many additional activities. He was one of the five founders of the journal, *SURGERY, GYNECOLOGY AND OBSTETRICS*, and served from its inception to his death on its editorial staff, for the last three years as its editor in chief, he was



We are all familiar I take it, or we should be, with the multiple activities of the College. I shall not enumerate them other than to indicate their wide range of usefulness. I have spoken of our College as a great clearing house, and this truly it has become. For examples, it receives from special committees, annual reports of clinical research of the standardization of hospitals and clinical laboratories, and of all the many problems that confront a surgical training and practice. Here, too, is our own Journal with the *INTERNATIONAL ABSTRACT OF SURGERY*, the *Bulletin*—a library of 25,000 volumes with current monographs and periodicals and its Department of Literary Research and, thank you, a "package library" which I am using now. The College has a palatial home, it has held 28 clinical congresses and nearly 200 sectional meetings, it has provided community health programs, round table talks, and a legion of lectures, both popular and scientific.

Why it reads, this curriculum, even as a liberal education. True it has cost the College three and three-quarter millions of dollars. An expensive mandate if you will, but the improvement in our hospitals alone is well worth the money.

This hospital standardization represents the largest work of its kind that has ever been undertaken, the largest, the most far reaching, and beneficent. In a true sense a hospital may be considered the fairest measure of any civilization, for it really shows how we treat the sick and the afflicted, and whether or no we are in any practical way our brother's keeper. This campaign, begun 21 years ago with only 89 hospitals meeting the requirement, now shows 2,621 fully approved. Read Malcolm T. MacEachern's textbook, *Hospital Organization and Management*, published 3 years ago.

From the first this College has been intensely engaged in education—the education of ourselves, the laity, and the profession, it is and always has been a great post graduate School. If any proof were wanting, just read the program of this annual meeting in New York. Everything is here: clinical, technical and scientific, and it is no 8 hour day. I can assure you. The sorrow is that one cannot be in two places at once, for with this embarrass-

ment of riches, the great difficulty is to choose.

Our College then is a great post graduate school, and in consequence, and for this very reason, it is intimately concerned with all medical education. During these years we have lived in the very midst of an American renaissance, and with truth it may be said that this College has borne a share in the great reform. In this time what a change has been wrought in our medical education! You can not make bricks without the proverbial straw, and now we are indeed proud of our 87 recognized medical schools.

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Progress is a sign of life, we cannot stand still. It seems to me that in this best and natural way we raise the College requirement and make the path straight toward an entrance examination for the Fellowship. Personally I believe in such an examination. Surgery is a science as well as an art, and at some time in his apprenticeship, the candidate is to be examined in the basic sciences—anatomy, physiology, and pathology, while later, if you will be is to present his case reports. The average man is lazy and indifferent—most of us are average—and he needs such an objective such a stimulus, to make him work. I have experi-

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## COMMENTS ON THE 1938 MEETING

HENRY W. CAVE, M.D., F.A.C.S., New York, New York

THE annual Clinical Congress of the American College of Surgeons is intended, primarily, to be an educational event. Therefore, its success is proportionate to the gains in knowledge and in understanding which those who attend it receive. Of course, it is quite impossible to calculate exactly how much more knowledge the 1938 delegation carried away than they brought with them, but it is entirely possible to judge of the aggregate educational benefits by analyzing the spirit shown at the meetings.

It was stimulating, in the first place, to note the interest in the subject of education for surgery itself, especially graduate education and training. Concern for the preparation of the new generation of surgeons shows appreciation of the increasing complexity of surgical problems. In the second place, it was impressive to see surgeons, who are recognized among the most competent in the profession, eagerly watching other surgeons, perhaps less well known, perform operations and demonstrate procedures. This bears testimony to the fact that the surgeon recognizes that the continual interchange of opinions and experiences is essential to keep him up-to-date and to maintain the required self-confidence for successful surgery. That the Clinical Congress presents a welcome opportunity for such interchange was most apparent, and it seems that every year the surgeon's zeal to learn grows in intensity as more knowledge accumulates.

A change is quite noticeable in the type of knowledge which the surgeon is seeking at the Clinical Congress. In the past he wanted to watch famous surgeons at work or to see unusual and extraordinary operative procedures. Of the 1938 Clinical Congress audiences, however, one surgeon remarked "They seemed to be not so much interested in brilliant, individual results as in a consideration of the commoner problems which confront a surgeon in his daily practice." This means that the mere fact that a problem is common does not imply

Chairman of the Committee on Arrangements

that it is easy to solve, or that, being constantly confronted with it, a surgeon becomes confident that he has learned all there is to be learned. It seems that the opportunities for widening knowledge afforded by this Clinical Congress is steadily increasing its educational value.

Fifty-two hospitals participated in the clinical program, the largest in point of clinics in the history of the Congress. Most of the operative clinics were well attended. A feeling is growing, however, that these have a disadvantage, in that only a few persons standing close to the operating table can see the details of operation. Surgery is becoming less dramatic and more physiological, the dry clinics and demonstrations, together with the scientific sessions and symposia, seem to provide the best media for dissemination of information. Presentation of a subject from all the different points of view, that of the surgeon, perhaps the specialist, the radiologist, the pathologist, the anesthetist, and others, gives opportunity for correlation which is invaluable.

The symposia on cancer, fractures, urological infections, surgical procedures on the handicapped patient, industrial medicine and traumatic surgery, and obstetrics and gynecology demonstrated the progress that has been made in the diagnosis and treatment of these various branches of surgery. The evening meetings, which were addressed by outstanding surgeons, some of whom were foreign guests, were well attended and the subject matters were received enthusiastically. The midday round table conferences were a new feature this year, and were outstandingly successful because of the opportunity they provided for more informal discussion than was possible at the larger meetings.

Wednesday was given over to the Brooklyn Chapter of the American College of Surgeons. In the Brooklyn hospitals a most thorough and complete clinical program was carried out, and the participation of our Brooklyn neighbors added much to the success of the Congress.

treasurer of the Clinical Congress during its seven independent years, and of the College, he was a founder, a governor and a regent, and active member of many committees and finally its president in 1931-32. Through it all, he was always the "man on deck," ready, purposeful, and competent. I can imagine no finer tribute than the one paid to him by his Journal on his sixtieth birthday in commemoration of these services, and of his 35 years of surgical teaching and practice.

A full life indeed and full to its tragic end!

All this work of course was the great center of his life but there were nevertheless certain

"margins of leisure" round about it, and these margins only the more clearly revealed the lovable character of the man. He was always a great reader and genuinely attached to books. It is in his library that I best remember him. Again he was fond of games, and of the open and the sky, and especially in his later years Nature in her changing moods, was a great solace to him.

The end came in a motor accident at the age of 64 years. He has passed from the sight of men, but he lives "in minds made better by his presence, and in thoughts that pierce the night like stars."

## TWENTY-FIRST ANNUAL HOSPITAL STANDARDIZATION CONFERENCE

MALCOLM T. MacEACHERN, M D , Chicago, Illinois

THE twenty-first annual hospital standardization conference, held in New York City in connection with the Clinical Congress of the American College of Surgeons, was exceptionally well attended, and it was noteworthy for the great amount of instructive and inspirational material which was presented.

Hospital executives showed special interest in the discussions of the College program to increase opportunities for graduate training in surgery and the surgical specialties, and gave assurances of their co-operation. This subject is treated in an article by the chairman of the Committee on Graduate Training for Surgery which appears on another page.

At a joint meeting with the Greater New York Hospital Association 5 of the more important subjects of general interest to hospitals today were discussed: graduate medical education, hospital insurance, standardization of equipment, financial safeguards for endowment funds, and the place of the voluntary hospital in society. In presenting the latter subject, David H. McAlpin Pyle, president of the United Hospital Fund of New York City, said that the element of competition between government and voluntary hospitals should gradually be lessened as it becomes evident that the two types of institutions are really complementary; the one assumes the bulk of the burden for hospitalization of patients of the lowest income class and of those afflicted with illnesses of long duration, and the other serves primarily the needs of those patients who can afford to pay all or something toward the cost of their care. Particularly constructive was his suggestion that the voluntary hospital make available, on a semi-philanthropic basis, the benefits of modern medicine and surgery to the middle classes through both the hospital's in and outpatient departments. This would remedy the fundamental defect in present day hospital service which tends to confine

such benefits to the rich who can pay well for them and the indigent who can pay nothing.

The value of organized voluntary service in hospitals and the co-operation of governmental and voluntary agencies in promoting the welfare and care of the sick is not only desirable but possible under conditions of co-operative leadership in the community. Between them there must be no conflict, is the belief of Dr. S. S. Goldwater, commissioner of hospitals, New York City.

Hospital problems of practically every nature were discussed at the various sessions of the conference, and an entire afternoon was devoted to demonstrations of administrative and technical procedures in local hospitals. At the opening session the progress of hospital standardization was briefly outlined and the customary announcement was made of the list of approved hospitals, based upon the 1938 survey. The list showed a total of 2,664 hospitals fully and provisionally approved. The increase over the 1937 figure of 2,621 hospitals is not large; but more new institutions are included than the difference would indicate, inasmuch as approval was withdrawn from a number of hospitals which had shown laxity in observing certain of the requirements of the Minimum Standard for Hospitals.

Some hospitals were not rated or were reduced in rating because their administrators did not measure up to the requirements of adequate training and experience in hospital administration, some because of evidences of fee splitting, a few because of extension of the privilege of hospital facilities to so called "irregular" practitioners, and others because of incomplete medical records, the use of nurses' aids to perform duties for which they are inadequately trained, and other deficiencies. The announcement redemonstrated the fact that approval is not automatically retained; but continuous effort by the hospital is necessary to remain on the approved list.

Among the distinguished guests from abroad who presented papers at the Congress were William H. Ogilvie, M.D., F.R.C.S., of London, England, who spoke on "Cancer of the Stomach," Professor Hans Finsterer, of Vienna, who read a paper entitled, "Results of Repeated Operations upon the Stomach, Especially Gastrojejunal Ulcers", and Professor Paul Werner, who described the Wertheim operation for cancer of the uterus. Mr. Ogilvie was granted an honorary fellowship.

Motion pictures again proved themselves to be valuable means of instruction. They were presented almost continuously and large audiences were always in attendance.

The link between the surgeon and the hospital, which constitutes his workshop, was again emphasized by the holding of the Hospital Standardization Conference in conjunction with the Clinical Congress. This important branch of the College activities is un-

doubtedly not appreciated sufficiently by the average surgeon, but those who attended the Clinical Congress and noticed the large and enthusiastic audiences at the hospital sessions received an insight into the value of Hospital Standardization.

The relation of the surgical profession to the public through the press has long been considered an important aspect of the Clinical Congress, both from an educational and an interpretive point of view. The local committee on public relations aided the chairman of the committee on public relations of the College in co-operating with the press representatives in the preparation of articles, thus avoiding misinterpretation of scientific facts.

The Committee on Arrangements is most grateful to those who took part in the programs, for their unfailing co-operation, and to those who attended the Congress, for their enthusiastic reception.

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The increasing determination to solve the maternal morbidity and mortality problem by constructive measures, which will insure better care, was evidenced in the devotion of an entire session to the discussion of the care of the mother and newborn in a general hospital. This symposium was preceded by the presentation of the minimum requirements of the American College of Surgeons for the obstetrical department in a general hospital.

Another general subject which was emphasized, and an entire session of discussion concentrated upon it, was the training of hospital executives. More and more the necessity is being appreciated of methodic instruction and systematic practical training for persons to whom the management of the hospital is entrusted. Hospital administration is a highly specialized profession. The political appointee who has no firsthand knowledge of hospital problems, cannot possibly direct a hospital in such a way that its maximum potentialities for service may be realized, irrespective of the quality of his general educational and personal status.

Medical records were discussed, as in previous years, in a joint conference with the Association of Record Librarians of North America, as well as in round table conferences. This subject is one which it is necessary to emphasize continuously because complete medical records are not only a means of determining medical progress, but are themselves if properly used, a factor in furthering advances. Unfortunately, all hospitals have not yet recognized the importance of such records. In a few cases correction of this one deficiency would entitle a hospital to a place on the approved list.

In the discussion of the effect of physical conditions in the environment of the patient

as related to his case, and the further influence of these conditions on the personnel concerned special reference was made to the subjects of proper lighting, air conditioning, noise control, color, and other factors which may have a direct or indirect bearing on the progress of disease and convalescence, and on the morale of the hospital personnel.

Of major importance was the discussion of trends in nursing education and nursing service, and the progress which has been made in evaluating criteria basic for good nursing service in the hospital. It is apparent that the art and science of nursing is developing a higher level of standards.

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# GRADUATE TRAINING FOR SURGERY AND THE SURGICAL SPECIALTIES

DALLAS B. PHEMISTER, M D , F A C S , Chicago, Illinois

THE subject of graduate training for general surgery and the surgical specialties was emphasized at the Hospital Standardization Conference and at several of the scientific sessions of the Clinical Congress. The program of the American College of Surgeons is aimed not only toward increasing the opportunities for graduate training, but also toward improving the quality thereof. The subject was presented in considerable detail, and was heartily endorsed by the many speakers who contributed their views. Unquestionably, all agreed that this program is a great potential power toward insuring steadily rising standards of surgery which will benefit the profession, the patient, and the public in general.

In planning a program of such scope and significance, it is to be expected that there will arise some differences of opinion as to the best methods to be employed. It is gratifying that so few criticisms have been forthcoming, and none of these have been of an obstructive nature, but have been the natural result of differences in physical plants, and of differing views as to how the desired ends may be attained, in fact, these criticisms have usually originated from misunderstanding. Through conferences and discussions the College has sought to reconcile the various viewpoints as to details of procedure in order that a program may be developed that is workable and yet flexible enough for adaptation under varying circumstances. Some believe, for instance, that the sort of opportunity for graduate training, which the College considers ideal, cannot be created except in university connected hospitals or very large hospitals with university affiliations. These conditions will gradually be supplied either by plans which are being devised for basic science training in university laboratories, or by co-operation between uni-

versities and hospitals through the exchange of residents so that a wider range of experience may be afforded.

There is no denying that the large city hospital, connected with a university, has an advantage in providing graduate training, since clinical and academic facilities are abundant and highly organized. This is no reason, however, for confining graduate training to such institutions. In the first place, the surveys made by the College prove that they do not provide enough opportunities to fill the existing need for adequately trained surgeons. In the second place, there are some strong arguments in favor of the less centralized, and really more typical smaller institutions as training grounds. In the third place, the communities outside the medical centers are in need of surgeons with good basic science education and some training in the specialties who wish to acquire training in general surgery which can best be gained in the hospital of average size and average equipment.

There is no intention, in striving to improve graduate training, to encourage all medical graduates, who aspire to become surgeons, to seek opportunities in university connected hospitals. Rather there is a pronounced desire to stimulate the medium sized hospital in the medium sized community to devise ways and means of combining its advantages, as a typical field for practical experience, with the facilities for basic scientific study and specialized experience offered by the medical school hospital. Basic science training may be had independent of affiliations with the pre-clinical departments of medical schools. In other words the greatest effect of the whole program can be, if the hospitals and medical schools rise to their opportunity, to decentralize graduate training for surgery, and to make it possible for medical graduates to acquire in the medical center a well rounded, basic science background which they can ap-

The increasing determination to solve the maternal morbidity and mortality problem by constructive measures, which will insure better care, was evidenced in the devotion of an entire session to the discussion of the care of the mother and newborn in a general hospital. This symposium was preceded by the presentation of the minimum requirements of the American College of Surgeons for the obstetrical department in a general hospital.

Another general subject which was emphasized and an entire session of discussion concentrated upon it, was the training of hospital executives. More and more the necessity is being appreciated of methodic instruction and systematic practical training for persons to whom the management of the hospital is entrusted. Hospital administration is a highly specialized profession. The political appointee, who has no firsthand knowledge of hospital problems, cannot possibly direct a hospital in such a way that its maximum potentialities for service may be realized irrespective of the quality of his general educational and personal status.

Medical records were discussed as in previous years, in a joint conference with the Association of Record Librarians of North America as well as in round table conferences. This subject is one which it is necessary to emphasize continuously because complete medical records are not only a means of determining medical progress but are themselves, if properly used, a factor in furthering advances. Unfortunately all hospitals have not yet recognized the importance of such records. In a few cases correction of this one deficiency would entitle a hospital to a place on the approved list.

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# SYMPOSIUM ON CANCER

## PRIMARY PULMONARY MALIGNANCY

### Treatment by Total Pneumonectomy

#### Analysis of 79 Collected Cases and Presentation of 7 Personal Cases

ALTON OCHSNER, M D , F A C S , and MICHAEL DeBAKEY, M D , New Orleans, Louisiana

UNTIL recently carcinoma of the lung has been considered a relatively infrequent condition. However, recent studies demonstrate that pulmonary malignancy is not only a common occurrence but is one of the most frequent carcinomas of the body. This increase in incidence of bronchogenic malignancy is undoubtedly both apparent and real, as evinced by autopsy series from the German Clinics. Junghanns found an incidence of pulmonary carcinoma of 1.67 per cent of all autopsies performed from 1893 to 1927. The incidence of primary pulmonary carcinoma in all malignancies found at autopsy was 14.27 per cent during the period from 1893 to 1897. Seyfarth found increases in the incidence of pulmonary carcinoma from 5.01 per cent during 1900 to 1906 to 8.75 per cent from 1919 to 1923. During the first half of 1924 there was an incidence of 15.5 per cent. Jaffé, of Chicago, believes that pulmonary carcinoma represents 11.47 per cent of all carcinomas, and that pulmonary carcinoma was second in frequency only to carcinoma of the stomach and of the intestine. Frissel and Knox, in a series of 3,659 autopsies, found 588 cases of carcinoma of which 39 were carcinoma of the lung, thus representing 6.6 per cent of the total carcinomas and 1.06 per cent of the total autopsies. D'Aunoy, Pearson, and Halpert reported that of 6,000 necropsies on persons over 1 year of age, performed in the Charity Hospital in New Orleans, primary carcinoma of the lung occurred in 70, or 1.1 per cent, and was almost as frequent as primary carcinoma of the biliary tract or of the pancreas. In 1,244 autopsies performed at the Touro Infirmary in New Orleans there were 259 cases with carcinoma. Twenty-three of the carcinomas originated in the bronchus. The incidence of bronchial carcinoma in the total autopsies was 1.8 per cent,

whereas that in all carcinomas was 8.8 per cent (36). It is evident, therefore, that the frequency of pulmonary carcinoma is high. The fact that in Jaffé's cases it was second only to carcinoma of the stomach emphasizes the necessity for its clinical consideration.

Although it is controversial whether the increase in pulmonary carcinoma in recent years is apparent or real, the German autopsy statistics would indicate that the increase is actual and not only apparent. There are several explanations for the actual increase in the incidence of pulmonary malignancies, most of which have not been satisfactory. A number of theories have been suggested. Winternitz, Wason, and McNamara, because of the presence of metaplasia in the bronchial mucosa of persons dying from influenza, suggested that this change is a precancerous lesion. The inhalation of irritating gases such as war gas or gas originating from the increased use of motor cars has been proposed as an etiological factor. In our opinion the increase in smoking with the universal custom of inhaling is probably a responsible factor, as the inhaled smoke, constantly repeated over a long period of time, undoubtedly is a source of chronic irritation to the bronchial mucosa. In addition to the actual increase in pulmonary malignancy, there is unquestionably a relative increase in those localities where routine postmortem examinations previously have not been made. This is due probably to the fact that the condition has not been suspected in many cases and adequate diagnostic procedures have not been employed. The recent development of thoracic surgery has stimulated interest in intrathoracic lesions. This, with the development of specialized methods of diagnosis, has facilitated the recognition of pulmonary malignancies.

#### PATHOLOGY

It is generally agreed that the lining cells of the alveoli rarely, if ever, give rise to malignant neoplastic growths. Consequently all carcinomas of

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ply under competent supervision in the average sized hospital, perhaps even in their home community. Surgeons so trained are more likely than not to remain in such communities, and thus there may result a more decentralization of surgical skill than now exists. The need is acute for more direction in the final stages of a surgeon's training, and for more consideration of just how he is to use his training in the place where he is needed most.

Admittedly, the problems are many. But as one speaker said at the Congress, most of the problems will be removed automatically by the passage of time, since recent graduates in medicine have a much better foundation upon which to build. For a short time, however, some concession must be made to argu-

ments for existing methods such as training through apprenticeship, when no better system is available and when the senior surgeon is competent and conscientious.

In all fields of life today the trend is toward systematization and organization for efficiency and for progress. Surely in a field in which human life is at stake, methods which are hazardous and unco-ordinated should be unhesitatingly outlawed. The large concepts of safer surgery, better surgery, and increasing conservation of human life demand for their realization that hospitals, medical schools, and the surgical profession unite to further a correlated system of training for surgery which will insure to every community a surgical service of unchallenged quality.

location and the extent of the lesion. Generally, the symptoms are not produced by the neoplasm itself, but are due to secondary changes resulting from its presence. The most constantly encountered symptoms are cough and thoracic discomfort. The latter may vary from a slight consciousness to actual pain within the thorax. In those cases in which ulceration occurs hemoptysis is a prominent manifestation. Whenever occlusion of the bronchus occurs atelectasis, with displacement of the mediastinum toward the affected side, and consequent infection produce marked symptoms. In the peripherally located tumors with extension to the pleura, evidences of pleurisy with effusion may be present. Symptoms which appear late are loss of weight and strength, dyspnea, and osteo-artropathy. Due to the circumferential growth the vascularity of the tumor in its central portion becomes impaired resulting in necrosis and abscess formation. Pulmonary abscess without an antecedent pneumonitis or foreign body aspiration should be considered of malignant origin until proved otherwise. Likewise an unexplained cough and hemoptysis in a patient past 40 years of age should be considered the result of carcinoma until this diagnosis is excluded. The physical findings in pulmonary malignancies are as protean as the symptoms and are dependent upon the location and extent of the lesion and secondary pulmonary changes which may be produced by it.

#### DIAGNOSIS

The most important factor in the diagnosis of pulmonary carcinoma is the consideration of its possible presence. This lesion invariably should be suspected in every patient 40 years of age or older with unexplained cough, hemoptysis, or thoracic discomfort. While roentgenography, without the use of contrast media, is usually of little or no value in the early diagnosis of non-obstructive bronchial neoplasms, careful stereo-roentgenographic studies are necessary in all such lesions. The roentgenographic interpretation of centrally located lesions is generally more difficult because of the confusion with hilar shadows produced by other lesions and normal structures. This is particularly significant because most pulmonary neoplasms occur in the hilar region. In centrally located lesions, after the condition has progressed to such an extent that bronchial obstruction occurs, atelectasis of one or more lobes develops, depending upon the degree of central location. The physical findings and particularly the roentgenographic manifestations of this condition are characteristic, i.e., dullness or shadow

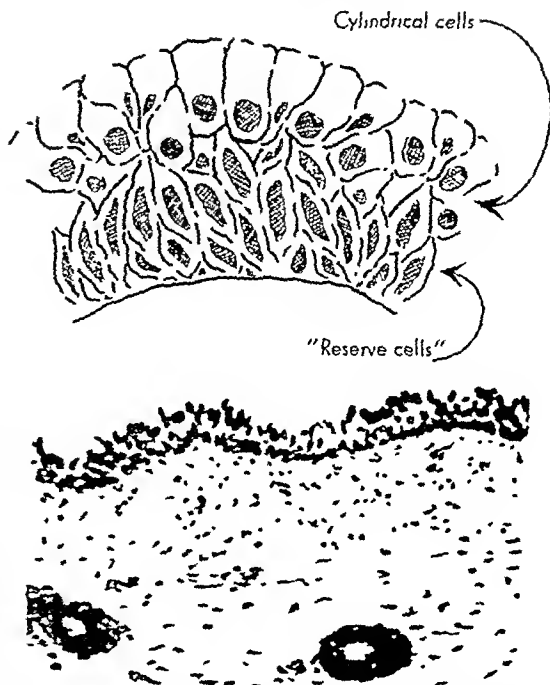


Fig 1 Lining cells of tracheal mucosa of a fetus 12 centimeters long. Beneath the cylindrical cells covering the surface there are several rows of nuclei of "reserve cells." Modified after D'Aunoy, Pearson, and Halpert (13, 26)

and displacement of the mediastinal structures toward the affected side (Fig 6). In peripherally located pulmonary malignancy the roentgenographic diagnosis is dependent upon shadows produced by the infiltrating tumor (Fig 7).

Of greatest importance, as regards accurate diagnosis, is bronchoscopic visualization of the tumor and biopsy obtained by this means. While the microscopic demonstration of malignancy of the bronchus is the ultimate ideal, there may be some difficulty in obtaining a satisfactory specimen. We are in complete accord with Jackson and Holinger that the incidence of correct diagnoses, made by bronchoscopic visualization of the lesion will probably be higher when made by one experienced in the bronchoscopic diagnosis of these tumors than by routine microscopic examination of biopsy specimens. This in part is due to the recalcitrance of most pathologists to diagnose carcinoma from the examination of a few cells, and it is also due to the fact that the inexperienced bronchoscopist may not obtain representative neoplastic tissue. In every instance, however, an attempt should be made to obtain tissue for microscopic examination, because, as



the lung are bronchiogenic. Carcinomas of the lung have been variously classified according to their morphological appearance. However, the most logical classification to us is that proposed by Béla Halpert. This classification is based upon the development of the cells lining the bronchi and this adequately explains the histological structure of all primary pulmonary carcinomas. Normally, the cells lining the mucous membrane of the bronchial tree represent varying degrees of differentiation and specialization of the original entodermal cells. According to Halpert, 'The epithelial cells covering the mucous membrane of the bronchial tree from stem to the minute branches are entodermal cells with a varying degree of differentiation and specialization. Apparently the undifferentiated entodermal ancestor cell is capable of developing into ciliated cylindrical epithelium, goblet cells, cuboidal cells, arranged into acinar and tubular structures producing a serous or mucous secretion indifferent cells, lining the ducts of these glands and into another kind of cuboidal or low cuboidal cells without cilia which line parts of the terminal bronchioles. In addition to the variety of cells just enumerated there are, beneath the ciliated cylindrical and goblet cells, a varying number of other epithelial cells which like the basal cells in the epidermis, are lined up along the border toward the tunica propria. They are the cells from which the single layer of ciliated cylindrical and goblet cells are replenished. These cells which may be called 'reserve cells' are the parent cells of the ciliated cylindrical, and goblet cells. In addition they naturally also possess the qualities of their ancestor cells in that they may differentiate into any kind of epithelium that an entodermal cell is capable of producing' (Fig. 1). According to Halpert, carcinomas of the lung originate from these 'reserve cells' by atypical proliferation.

These malignant growths may, therefore, be classified into 3 types, depending upon the embryological direction of growth: (1) the "reserve cell" carcinoma, (2) cylindrical-cell carcinoma and (3) squamous cell carcinoma. This conception of the embryological development of carcinomas is graphically illustrated by the development of the cells of the bronchial mucosa from a primitive entodermal cell (Fig. 2). According to D. Aunoy, Pearson, and Halpert the "reserve cell" carcinomas consist of round, elongated, or polygonal cells growing in solid masses and forming no particular structure. Characteristically they have a palisade arrangement of the peripheral cells (Fig. 3). The cylindrical cell carcinomas are

composed of cuboidal or columnar cells forming tubular or acinar structures, or are mounted on delicate connective tissue stalks in a papillary arrangement (Fig. 4). The squamous cell carcinomas have a tendency toward keratinization or to pearl formation with central keratinization (Fig. 5). A given tumor is as differentiated as its most differentiated part. If one accepts Halpert's classification, it is evident that only the 'reserve cell' carcinoma might be radiosensitive. As these represent, according to D. Aunoy, Pearson, and Halpert, approximately one third of all carcinomas of the lung, it is obvious that relatively few pulmonary neoplasms should on a theoretical basis at least, be radiosensitive. This is corroborated by the poor results obtained from this form of therapy. According to Halpert the gross characteristics of pulmonary carcinoma are in no way dependent upon the microscopic structures, but depend upon rapidity of growth and secondary changes which occur in the tumor such as hemorrhage and necrosis.

As regards the location of primary neoplasia of the lung, the right side is involved slightly more often than the left. In Fischer's series of 3,735 cases of pulmonary carcinoma the right side was involved in 53 per cent and the left in 45 per cent. In 2 per cent the lesions were bilateral. It is of interest that in 46, in which localization was given of the 79 collected cases in which total pneumonectomy was performed for pulmonary neoplasm the right side was involved in 19 or 41.3 per cent, whereas the left was involved in 27 patients or 58.6 per cent. In 784 of Fischer's cases in which the location according to the bronchus was designated the findings were as follows: The right main bronchus was involved in 142, the left main bronchus in 115, the right upper lobe bronchus in 148, the left upper lobe bronchus in 130, the right lower lobe bronchus in 129, the left lower lobe bronchus in 105, and the middle lobe in 15. Most pulmonary neoplasms are centrally located i.e. of hilar origin. According to Boyd 90 per cent of these neoplasms are in the region of the hilum. In Frissel and Knox's series the incidence of hilar carcinomas was not so high, only 49.7 per cent. Seventeen and eight tenths per cent involved the parenchyma and were of the nodular variety. 6.5 per cent were peripheral. 23.9 per cent were diffuse and 2.1 per cent were bilateral. Hilary.

#### SYMPTOMATOLOGY

There are few or no symptoms in the early course of bronchial carcinoma. The symptoms vary considerably and depend entirely upon the

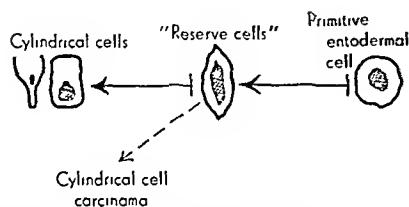


Fig 4 Cylindrical cell carcinomas are composed of cuboidal or columnar cells forming acinar, tubular, or papillary structures. The parent cells are the "reserve cells" which form haphazard imitations of the normal epithelial cell structure which composes the air passages. Modified after the method of D'Aunoy, Pearson, and Halpert (13, 26)

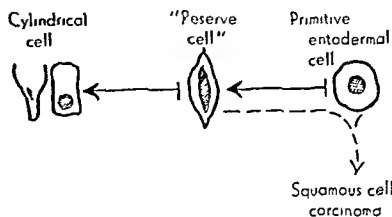


Fig 5 Squamous cell carcinomas grow in nests of cells in a concentric arrangement forming epithelial pearls with central keratinization. The endodermal cell of the air passages has the quality of producing stratified squamous epithelium. The parent cell of this carcinoma is a "reserve cell" of earlier ancestry than the ordinary. Modified after D'Aunoy, Pearson, and Halpert (13, 26)

reported cases resections of the involved lobes have been performed, it seems to us that any procedure, short of total removal of the involved lung, is irrational. Only by complete excision of the entire lung can the primary focus be adequately removed, and lobectomy does not permit removal of the regional lymph nodes. The performance of simple lobectomy in carcinoma of the lung is just as illogical as partial removal of the breast in mammary carcinoma with no attempted extirpation of the regional lymph nodes. Another reason for total pneumonectomy is that approximately 75 per cent of pulmonary neoplasms originate in the proximal bronchi. As shown by Bonniot, Monod, and Evrard, it is not possible to apply a tourniquet high enough on the pedicle of the lung to permit division of the main bronchus without injuring the pericardium or other mediastinal structures. Moreover, from a technical standpoint, total pneumonectomy is a much more surgical and anatomical procedure than is lobectomy. The latter at best consists more or less of a makeshift operation. It is necessary almost invariably to cut through pulmonary tissue because of the incomplete division of the lung down to the hilum by the fissures which does not permit individual ligation of the bronchus and pulmonary vessels.

On the basis of our experience we are convinced that preliminary pneumothorax should be attempted in all cases of malignancies of the lung. This should be done preferably in stages, increasing the amount of intrapleural pressure

gradually until the pressure is definitely upon the positive side. Most surgeons agree that a preliminary pneumothorax is desirable. The procedure was originally advocated by Kuemmel who performed the first pneumonectomy in November, 1910. Pre-operative pneumothorax is of diagnostic importance in determining the presence, extent, and location of adhesions, thus permitting the pre-operative planning of the operative procedure. In those cases in which extensive basal adhesions are present, a posterolateral approach is preferable to an anterior one, whereas, conversely, a patient with adhesions involving the apex can best be operated upon through an anterior approach. Another decided advantage of pre-operative pneumothorax is the gradual compression of the pulmonary capillary bed, giving the right heart a chance to compensate for the increased peripheral resistance in this area, rather than permitting a sudden cutting off of the blood to the involved lung at the time of the ligation of the pulmonary vessels. This is particularly true in elderly patients whose cardiac reserve is diminished, and in whom malignancies of the lung are likely to occur.

Rienhoff (46) advocates the pre-operative introduction of beef broth bouillon into the pleural cavity in order to produce a serofibrinous pleurisy, which he believes decreases the incidence of infection following the operation.

Patients with pulmonary carcinoma usually have an anemia because of the associated infection and loss of blood. In such instances pre-

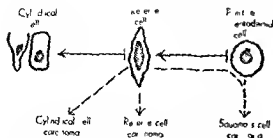


Fig 2 The reserve cell is the parent cell of the cultured cylindrical and goblet cells and also possesses the qualities of its ancestor cell in that it may differentiate into any kind of epithelial cell that a primitive endodermal cell is capable of producing. Hence the carcinomas of the lung may be (1) reserve cell carcinoma (2) cylindrical cell carcinoma and (3) squamous-cell carcinoma. Modified after D. Aunoy, Pearson and Halpert (13, 16).

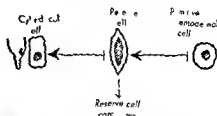


Fig 3 Reserve-cell carcinomas grow in solid masses composed of round, elongated (oat cell) or polygonal cells forming no particular structure. Usually there is a palisade arrangement of the peripheral cells. Modified after D. Aunoy, Pearson and Halpert (13, 16).

mentioned, this is the ideal method of diagnostic proof. According to Jackson and Konzelmann, the incidence of correct diagnoses obtained broncho-copically is approximately 75 per cent. This is about the incidence of hilar tumors and indicates that those cases, which are close enough to the main stem bronchi to be visualized, can be diagnosed by the trained bronchoscopist. Difficulty is likely to be encountered in eparterial bronchus tumors because of their location and because of the acute angle which they form with the right stem bronchus. Visualization usually can be obtained in those cases, however, in which the neoplasm is near the orifice of the eparterial bronchus.

The presence of malignant cells in expectorated material can frequently be demonstrated microscopically. By this method of examination, Dudgeon found carcinoma cells in 60 per cent of patients in whom a diagnosis of pulmonary neoplasm subsequently was proved. Similarly, the demonstration according to Mandelbaum's technique of malignant cells in the pleural fluid of those cases in which there has been extension to the pleura is of diagnostic importance. The latter is of little use early in the disease, however, because of the relatively late extension to the periphery, except in peripherally located lesions. The importance of this method of diagnosis lies principally in its prognostic value.

Thoracoscopic examination is another method of diagnosis in selected cases of pulmonary carcinoma and is particularly valuable in those cases with peripheral extension with or without pleural effusion. This method of examination is useful in determining the cause of the pleural effusion and the operability of the case. In those cases in which there is extensive seeding in the pleural

cavity, an attempt at radical extirpation is obviously not justified. In cases in which the lesion is located peripherally, obviating bronchoscopic visualization of the tumor, aspiration biopsy can be performed with relative safety and with a fair degree of accuracy. Martin and Ellis, in 1930, reported their results in a large series of aspiration biopsies done for a variety of conditions. In 2 pulmonary carcinomas microscopic diagnoses of the lesions were positive. Sharp reports 3 cases in which a positive microscopic diagnosis of pulmonary neoplasm was made on material obtained by aspiration. He believes that the method is particularly valuable in upper lobe malignancies. Binkley, reported a aspiration biopsy of the thorax performed in the Memorial Hospital. In 56 bronchogenic carcinomas a positive diagnosis was made by aspiration biopsy in 60 per cent, whereas bronchoscopic examination gave a positive diagnosis in only 43 per cent of this group. An accurate diagnosis is possible following aspiration biopsy only if the examining pathologist is capable of interpreting the changes occurring in the few cells obtained by this method, and if he is willing to commit himself on the basis of these findings.

#### TREATMENT

The treatment of carcinoma of the lung, as that of most carcinomas elsewhere, consists ideally of complete surgical extirpation. Surgical removal is particularly indicated in pulmonary malignancies because of the almost hopeless outlook following other types of therapy. While in a number of

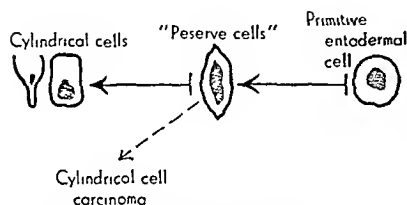


Fig 4 Cylindrical cell carcinomas are composed of cuboidal or columnar cells forming acinar, tubular, or papillary structures. The parent cells are the "reserve cells" which form haphazard imitations of the normal epithelial cell structure which composes the air passages. Modified after the method of D'Aunoy, Pearson, and Halpert (13, 26)

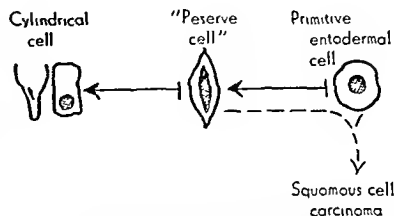


Fig 5 Squamous cell carcinomas grow in nests of cells in a concentric arrangement forming epithelial pearls with central keratinization. The endodermal cell of the air passages has the quality of producing stratified squamous epithelium. The parent cell of this carcinoma is a "reserve cell" of earlier ancestry than the ordinary. Modified after D'Aunoy, Pearson, and Halpert (13, 26)

reported cases resections of the involved lobes have been performed, it seems to us that any procedure, short of total removal of the involved lung, is irrational. Only by complete excision of the entire lung can the primary focus be adequately removed, and lobectomy does not permit removal of the regional lymph nodes. The performance of simple lobectomy in carcinoma of the lung is just as illogical as partial removal of the breast in mammary carcinoma with no attempted extirpation of the regional lymph nodes. Another reason for total pneumonectomy is that approximately 75 per cent of pulmonary neoplasms originate in the proximal bronchi. As shown by Bonniot, Monod, and Evrard, it is not possible to apply a tourniquet high enough on the pedicle of the lung to permit division of the main bronchus without injuring the pericardium or other mediastinal structures. Moreover, from a technical standpoint, total pneumonectomy is a much more surgical and anatomical procedure than is lobectomy. The latter at best consists more or less of a makeshift operation. It is necessary almost invariably to cut through pulmonary tissue because of the incomplete division of the lung down to the hilum by the fissures which does not permit individual ligation of the bronchus and pulmonary vessels.

On the basis of our experience we are convinced that preliminary pneumothorax should be attempted in all cases of malignancies of the lung. This should be done preferably in stages, increasing the amount of intrapleural pressure

gradually until the pressure is definitely upon the positive side. Most surgeons agree that a preliminary pneumothorax is desirable. The procedure was originally advocated by Kuemmel who performed the first pneumonectomy in November, 1910. Pre-operative pneumothorax is of diagnostic importance in determining the presence, extent, and location of adhesions, thus permitting the pre-operative planning of the operative procedure. In those cases in which extensive basal adhesions are present, a posterolateral approach is preferable to an anterior one, whereas, conversely, a patient with adhesions involving the apex can best be operated upon through an anterior approach. Another decided advantage of pre-operative pneumothorax is the gradual compression of the pulmonary capillary bed, giving the right heart a chance to compensate for the increased peripheral resistance in this area, rather than permitting a sudden cutting off of the blood to the involved lung at the time of the ligation of the pulmonary vessels. This is particularly true in elderly patients whose cardiac reserve is diminished, and in whom malignancies of the lung are likely to occur.

Rienhoff (46) advocates the pre-operative introduction of beef broth bouillon into the pleural cavity in order to produce a serofibrinous pleurisy, which he believes decreases the incidence of infection following the operation.

Patients with pulmonary carcinoma usually have an anemia because of the associated infection and loss of blood. In such instances pre-

operative unmodified blood transfusions are desirable. It is also imperative that two or more donors be available at the time of operation, because prolonged bleeding may follow division of extensive adhesions and because of possible accidental massive hemorrhage in which the administration of blood during the operation is frequently life saving.

**Anesthesia.** Although pneumonectomy may be performed under local and spinal analgesia the latter being particularly popular in Canada and England we prefer cyclopropane inhalation anesthesia. Because of the wide opening in the chest wall it is necessary that the anesthetic be administered under positive pressure. All of our earlier cases were done under positive pressure intratracheal tubes being used, but we now are convinced and agree with Rienhoff (46) that the use of the intratracheal tube is deleterious, because of the likelihood of the introduction of infection and the increased secretion resulting from trauma which in the presence of a single lung following pneumonectomy, is particularly dangerous. One of our fatalities 14 hours after operation undoubtedly was due to trauma of the trachea by the intratracheal tube, resulting in such excessive secretion that the patient virtually drowned in her own secretions despite almost continuous aspiration (Case 5).

In those cases in which the pleural cavity is free, containing no adhesions the anterior approach advocated by Rienhoff (47, 48) is very satisfactory. Instead of the intercostal incision suggested by Rienhoff we are of the opinion that resection of the third rib from the lateral border of the sternum to the anterior axillary line is preferable (Figs 8-9). This gives a better exposure and permits a more satisfactory closure because it facilitates accurate approximation without tension of the pleura and intercostal muscles. The anterior approach is also applicable to those cases in which the lesion is located in the periphery of the upper lobe, and in which there are adhesions between the upper lobe and the parietal pleura. This approach however is not recommended for those patients in whom there are adhesions between the lower lobe and the posterior parietal pleura, because of the great difficulty encountered in mobilizing the lung. In such cases resection of the fifth rib through the incision suggested by Crafoord has been more satisfactory in our hands (Figs 10, 11-1).

A distinct advantage of the latter approach in addition to permitting the division of adhesions between the lower lobe and the lateral and posterior parietal pleuras under direct vision is that

the hilum can be approached from behind, thus allowing initial mobilization of the relatively fixed bronchus. Following division of the bronchus, which normally holds the hilar structures quite rigidly, dissection of the other hilar structures the pulmonary artery and veins, is greatly facilitated (Fig 13). In the posterior approach also, rib resection is preferable to intercostal incision. After the pleural cavity is opened and the lung is mobilized by division of adhesions by sharp dissection the hilum is exposed in the mediastinum by incising the mediastinal pleura anteriorly and superiorly in the anterior approach and posteriorly and superiorly in the posterior approach (Fig 14). The flap of mediastinal pleura thus formed is mobilized, thus exposing the hilar structures. The mobilization is greatly facilitated by the use of long ball tipped slightly curved scissors (Fig 14). The pulmonary artery, pulmonary veins, and bronchus are isolated individually (Fig 15).

Mass ligation of the hilum is to be condemned as an unsurgical procedure and one which will give bad results in the majority of cases because of the incomplete extirpation. It does not permit removal of the mediastinal lymph nodes in which metastases are likely to occur, and in many instances does not permit the complete removal of the tumor. This is particularly exemplified in our first case in which the tumor was located just beyond the bifurcation of the trachea in the left main stem bronchus. Although individual ligation of the hilar structures was performed the bronchus was divided insufficiently high to include the tumor. The pathologist who was present at the operation, noticed the absence of the tumor before the mediastinal wound was closed permitting further dissection of the bronchus up to the carina and the high removal of the bronchus and the adjacent wall of the trachea (Fig 16). The tumor was situated in the small segment of bronchus which was approximately 2 centimeters in length. The posterior approach is particularly applicable and desirable in those cases of right sided malignancies because of the greater difficulty in approaching the hilum on this side due to the presence of the vena azygos extending over the eparterial bronchus. This is especially true in cases in which the lesion originates in the eparterial bronchus and in which extension to the mediastinum in this area is likely to be present. In 2 of our cases the inability to free the bronchus anteriorly necessitated ligation of the vena azygos. Subsequent slippage of the ligature resulted in fatal hemorrhage (Case 2). Through the posterior approach the vena azygos can be



Fig 6 Anteroposterior roentgenogram of chest of patient with carcinoma involving right lower lobe bronchus as characterized by slightly rounded but irregular shadow in lower right lung field adjacent to hilum. The mediastinum is displaced slightly toward the affected side (Case 3)



Fig 7 Anteroposterior roentgenogram of chest of patient with carcinoma of right upper lobe bronchus which had extended peripherally to involve practically the entire lobe as confirmed by subsequent examination. The area of increased density, occupying nearly the whole upper lobe of the right lung, is produced by the peripheral extension of the tumor and not by atelectasis which would cause displacement of the mediastinum toward the affected side (Case 2)

more easily and more safely ligated before the bronchus is isolated (Fig 13). Separate ligation of the pulmonary vessels is imperative, and is perfected by double transfixion sutures (Fig 17). The use of No. 2 silk, which is sufficiently strong to compress the vessels and not too large to interfere with the tying of the knot, is considered preferable to other suture materials. The bronchus is doubly clamped by means of crushing forceps and divided between the clamps (Fig 13). Before the bronchus is closed by means of interrupted No. 1 silk sutures, approximating the mucosal edges, the distal cartilaginous ring is removed from the end of the bronchus. The removal of all the mediastinal lymph nodes is an essential part of the operation and can be accomplished either through the anterior or the posterior approach. Obviously mass ligation of the hilar structures will not permit this.

Following the complete extirpation of all the mediastinal lymph nodes careful pleuralization of the mediastinum is imperative. The edges of the divided mediastinal pleura are approximated, and the stump of the ligated vessels and bronchus is covered with pleura (Fig 18). This is important to minimize the danger of infection and augment prompt healing of the bronchial stump.

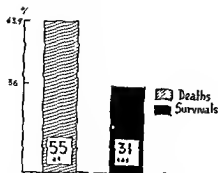
In our cases we have not resorted to drainage, because we believe with Rienhoff (49) that filling of the pleural cavity with fibrinous exudate is important in the obliteration of the cavity. Ob-

literation of the cavity also is facilitated by elevation of the diaphragm which follows crushing of the phrenic nerve at the beginning of the operation. The thoracic wound is tightly closed, using interrupted No. 1 silk sutures for the pleura and the intercostal muscles. The superficial muscles and the skin are closely approximated by means of the same material. A compression sea sponge bandage is applied over the wound to obliterate the dead space and to lend support to the wound.

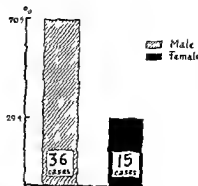
#### ANALYSES OF CASES

There have been 79 reported cases of total pneumonectomy for neoplastic disease. In addition to this number, the authors have performed total pneumonectomy for malignant disease of the lung in 7 cases making a total of 86 cases<sup>1</sup> (Table I, Graph 1). Of the 86 collected cases, including those of the authors, 55 (63.9 per cent) died and 31 (36 per cent) recovered. Of the 31

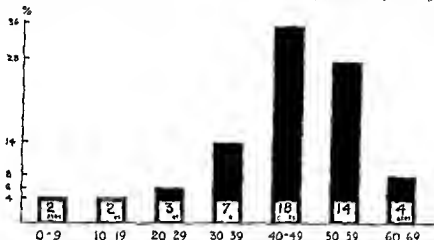
<sup>1</sup>Since this presentation 2 more patients have been operated upon. One, a male, age 56 years, had carcinoma of lower left bronchus. Pneumonectomy of left lung was performed November 17, 1938. Patient made uneventful recovery. The second patient was a white female with a metastatic melanoma of left main stem bronchus having its origin from a melanoma of right eye removed 23 years previously. Pneumonectomy of left lung was done October 12, 1938. Patient died 12 days after operation of uremia. Thus of total series of 9 cases 3 have recovered and 6 have died, giving a total mortality of 66 per cent.



Graph 1 Graphic representation of total mortality in 51 collected cases of pneumonectomy for neoplastic disease including 7 performed by the authors



Graph 3 Graphic representation of sex incidence in 51 collected cases of pneumonectomy including authors



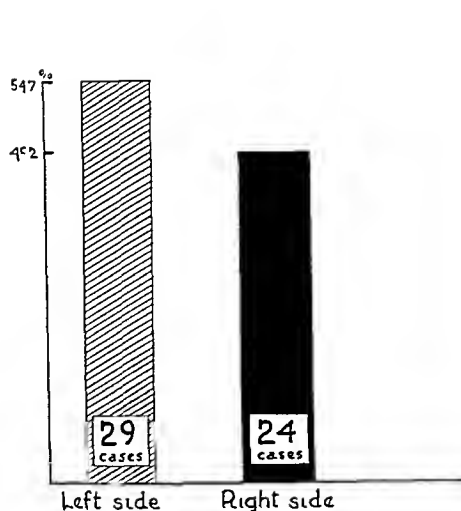
Graph 2 Graphic representation of age incidence according to decades in 50 collected cases of pneumonectomy including authors

patients who recovered there were 5, or 5.8 per cent of the entire group of 86 who subsequently died either of metastases or of other causes. In 50 the age of the patient was stated. Two (4 per cent) were in the first decade of life, the younger being  $3\frac{1}{2}$  years of age with a lymphosarcoma. 2 (4 per cent) in the second decade, 3 (6 per cent) in the third decade, 7 (14 per cent) in the fourth decade, 18 (36 per cent) were in the fifth decade, 14 (28 per cent) in the sixth decade and 4 (8 per cent) in the seventh decade (Graph 2). Of the 50, 32 (64 per cent) occurred in the fifth and sixth decades. Of significance also is the fact that 14 (28 per cent) were younger than forty years of age.

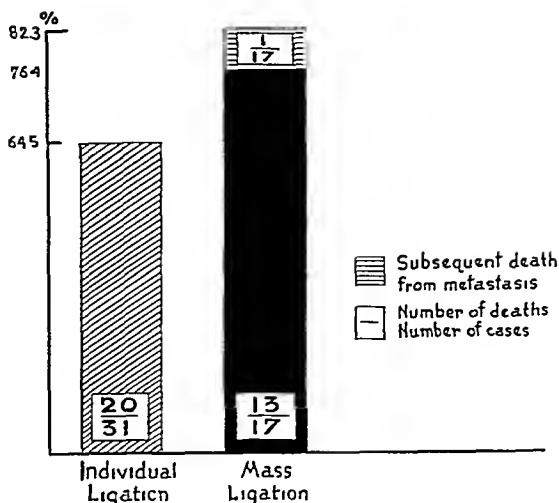
The sex was stated in 51 cases including the authors' cases, of which 36 (70.5 per cent) were males and 15 (29.4 per cent) were females (Graph 3).

The localization as regards the side involved was stated in 53 cases. The left side was involved in

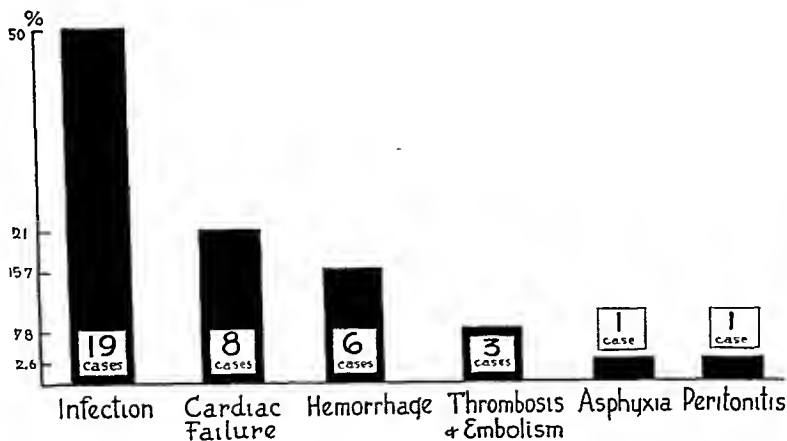
29 (54.7 per cent) and the right in 24 (45.2 per cent) (Graph 4). In 31 cases, including all of the authors', individual ligation of the hilar structures was done. Of this group 11 (35.4 per cent) recovered and 20 (64.5 per cent) died. Of 17 cases in which mass ligation was done and so stated, 4 (23.5 per cent) recovered and 13 (76.4 per cent) died. If we included in the fatal group having mass ligation 1 of the patients recovering who subsequently died of metastases, and in whom death may have been the result of incomplete removal of the lung, these respective figures would be 17.6 per cent and 82.3 per cent (Graph 5). This difference in the mortality percentage in the two techniques of treatment of the hilar structures demonstrates the superiority of individual ligation of the bronchus and pulmonary vessels combined with extirpation of the mediastinal lymph nodes.



Graph 4 Graphic representation of localization, according to side involved, of pulmonary neoplasms in 53 collected cases of pneumonectomy including authors'



Graph 5 Graphic representation of mortality in 48 collected cases of pneumonectomy including authors', according to treatment of hilar structures



Graph 6 Graphic representation of cause of death in 38 collected cases of pneumonectomy including authors'

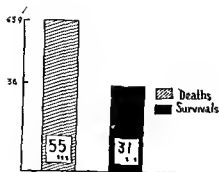
In 38 collected cases, including the authors' series, death as a result of the operation was due to the following: 6 (15.7 per cent) hemorrhage, 8 (21 per cent) cardiac failure, 19 (50 per cent) infection, 2 (5.2 per cent of the total) late hemorrhage as a result of the infection, 3 (7.8 per cent) thrombosis and embolism, 1 (2.6 per cent) asphyxia, and 1 (2.6 per cent) peritonitis (Graph 6).

The type of neoplasm was stated in 66 cases including the authors'. Fifty-nine (89.3 per cent) were carcinoma, 4 (6 per cent) were primary sarcoma, 2 (3 per cent) were metastatic lesions,

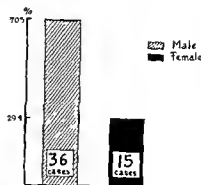
(1, a metastatic sarcoma from a primary focus in the uterus, and 1, a melanoma in which the primary lesion had previously been removed. It was the surgeon's opinion in the latter case that the lung extirpation had resulted in recovery) In 1 (1.5 per cent) the lesion was found to be benign (Graph 7)

It has been the authors' experience that a total pneumonectomy on the right side is technically more difficult than that on the left, due principally to the fact that on the right side the vena azygos crosses over the eparterial bronchus, usually making the mobilization of the right main-

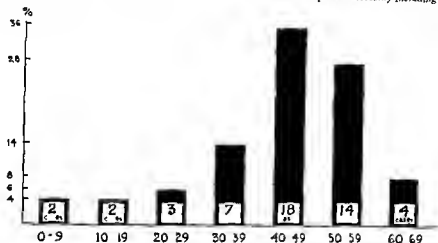




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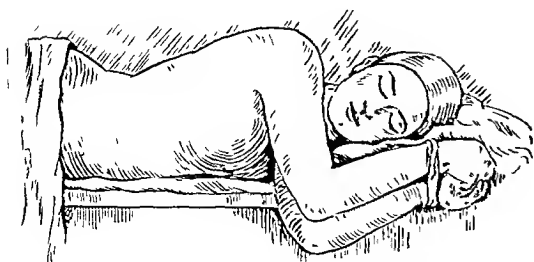


Fig 10 Drawing showing position of patient in posterior approach for pneumonectomy

there was electrocardiographic evidence of considerable myocardial damage. During the first 4 postoperative days his convalescence was very satisfactory. On the fifth day the pulse became irregular but slow, and about 10 hours after this developed the patient died. Postmortem examination revealed no other cause of death, except myocarditis (Case 6). One patient died of peritonitis from rupture of the intestine as a result of gangrene complicating a periarteritis nodosa of the mesenteric vessels 10 days after operation. The pulmonary wound was well healed, and there was no evidence of any disturbance in the chest (Case 3). One patient is living  $2\frac{1}{2}$  years after operation (Case 1). The remaining patient survived the operation but the operation was done so recently that it is too soon to draw any conclusions concerning the outcome (Case 7).

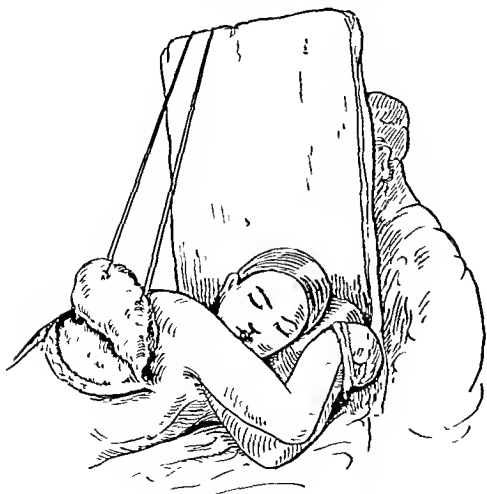


Fig 12 Drawing showing method of elevating angle of scapula so as to expose the fifth rib along its entire length. The fifth rib is subperiosteally resected throughout its entire length and the pleura is opened by incising in the furrow left by the rib.

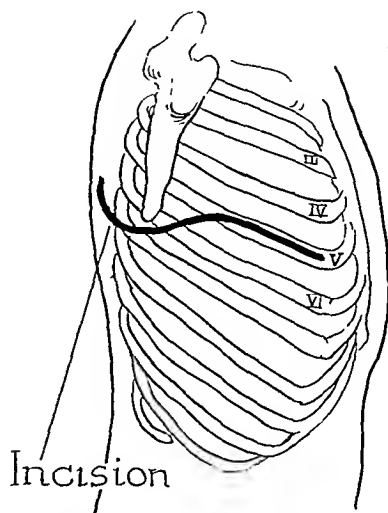


Fig 11 Drawing illustrating skin incision in posterior approach for pneumonectomy as devised by Crafoord. The incision begins over the fourth rib about 7 to 8 centimeters from the posterior midline, is extended downward beneath the angle of the scapula, and then up toward the midaxillary line to the level of the fifth rib which is followed anteriorly to the costal cartilage.

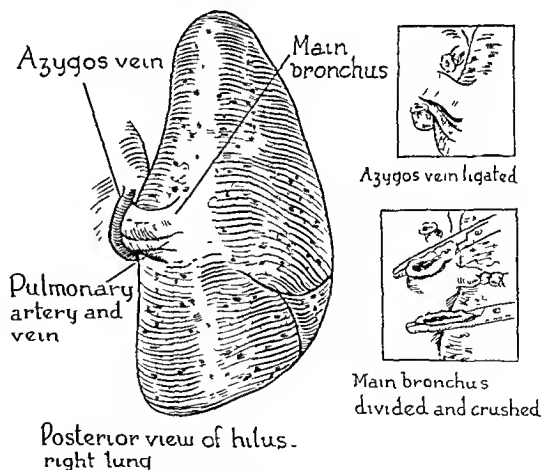
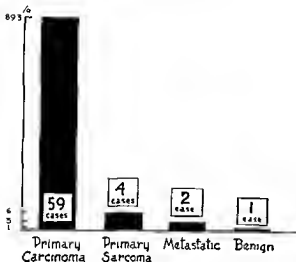
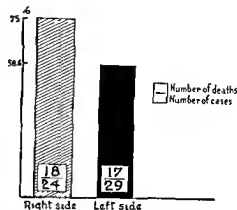


Fig 13 Drawing showing relation of hilar structures and steps of operation in posterior approach for pneumonectomy. The hilar structures are exposed by incising mediastinal pleura posteriorly and superiorly. The azygos vein is first exposed, doubly transfixed and ligated, and then divided between these ligatures. This permits easy access to the bronchus which is doubly clamped by means of crushing forceps and divided between the clamps. Following division of bronchus, which normally holds the hilar structures quite rigidly, dissection of the other hilar structures, the pulmonary artery and veins, is greatly facilitated.



Graph 7. Graphic representation of type of neoplasm in 66 collected cases of pneumonectomy including authors.



Graph 8. Graphic representation of mortality in 33 collected cases of pneumonectomy including authors according to side of operation.

stem bronchus difficult. This is borne out by the results obtained in right and left sided lesions in the collected cases including the authors. Of 24 patients with right sided lesions, 6 (25 per cent) recovered, and 18 (75 per cent) died. Of 29 patients who were afflicted with left sided lesions, 12 (41.3 per cent) recovered and 17 (58.6 per cent) died (Graph 8).

Of the authors' 7 cases, 5 died and 2 recovered, giving a mortality rate of 71.4 per cent and a recovery incidence of 28.5 per cent. Of the 5 fatal cases, 1 died on the table of hemorrhage as a result of slippage of the ligature from the vena azygos shortly after it was applied. In this case there was infiltration of the mediastinum in the region of the vena azygos, the tumor extending from the eparterial bronchus (Case 2). One died of asphyxia about an hour after the completion of the operation because of the tongue dropping back

before the patient had sufficiently recovered from the anesthetic (Case 4). One patient died as a result of severe tracheitis and pulmonary edema in the opposite lung which, in the authors' opinion was the result of trauma to the trachea by the intratracheal tube (Case 5). One died of cardiac failure 5 days after the operation. Pre-operatively

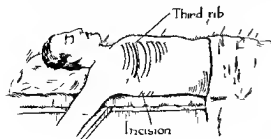


Fig. 8. Drawing illustrating site of skin incision over third rib from chondrosternal junction to anterior axillary line in anterior approach for pneumonectomy.

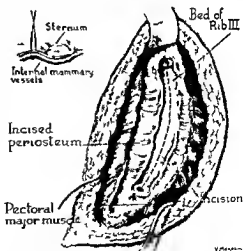


Fig. 9. Drawing illustrating anterior approach for pneumonectomy. The third rib is resected subperiosteally from chondrosternal junction to anterior axillary line. Incision of the pleura is made in the bed of the third rib. Inset shows exposure and immediate ligation of internal mammary vessels.

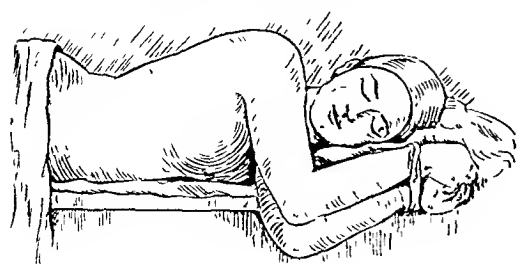


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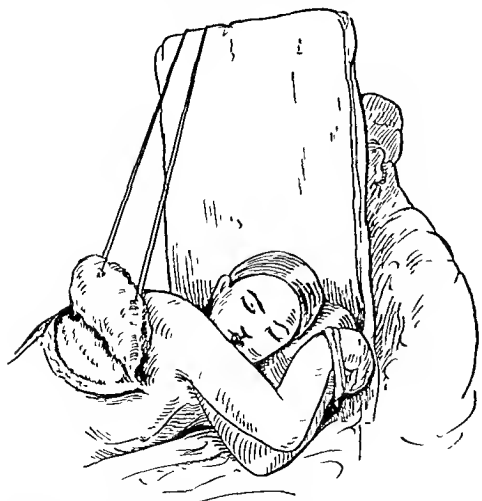


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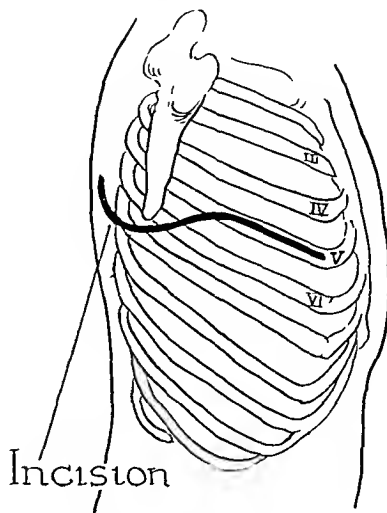


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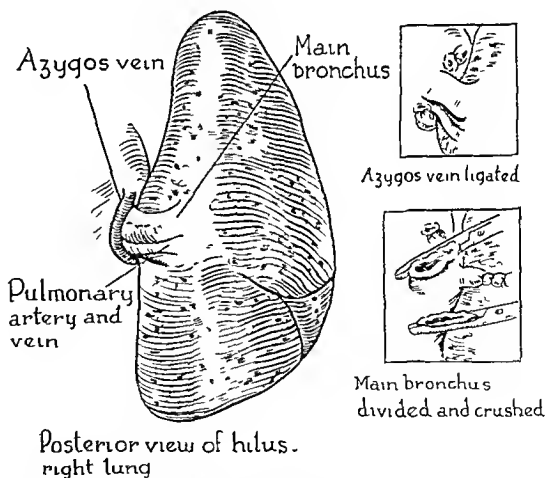


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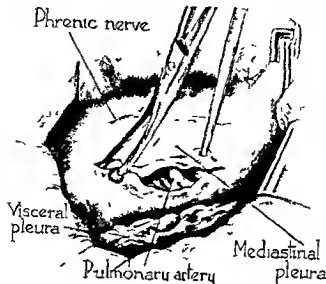


Fig 14 Drawing showing incision of mediastinal pleura in anterior approach for pneumonectomy. Mobilization of flaps of mediastinal pleura is greatly facilitated by use of long ball tipped slightly curved scissors

#### SUMMARY

1 Primary pulmonary carcinoma is an important clinical entity because of its frequent occurrence. It occurs in approximately 1 to 2 per cent of all autopsies and from 10 to 15 per cent of all carcinomas.

2 Chronic irritation of the bronchial mucosa is probably the most important etiological factor. Repeated inhalation of smoke over long periods of time is believed to be a prominent, irritative factor.

3 All pulmonary carcinomas probably originate in the bronchial mucosa. A classification

based upon the embryological derivation of the tumor cell is presented.

4 Persistent cough with expectoration and hemoptysis, and thoracic discomfort are the most prominent symptoms and when present in a person past 40 years of age should always be considered as due to pulmonary neoplasm until proved otherwise.

5 Roentgenographic examination is particularly valuable in peripherally located lesions with parenchymal infiltration and in centrally located lesions with bronchial obstruction. Because most bronchial malignancies occur in the primary bronchi, bronchoscopy is especially valuable as a diagnostic procedure.

6 Treatment of pulmonary malignancy consists of total extirpation of the involved lung and removal of the mediastinal lymph nodes. Lobectomy and mass ligation of the hilar structures are condemned because they do not permit complete eradication of the lesion. Preliminary pneumothorax always should be attempted. Depending upon the location of the lesion, the presence and extent of adhesions, either the anterior or posterior approach with rib resection should be used in the treatment of these patients.

7 An analysis of 79 collected and 7 personal cases of total pneumonectomy for neoplastic disease is presented.

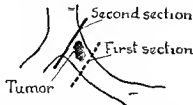
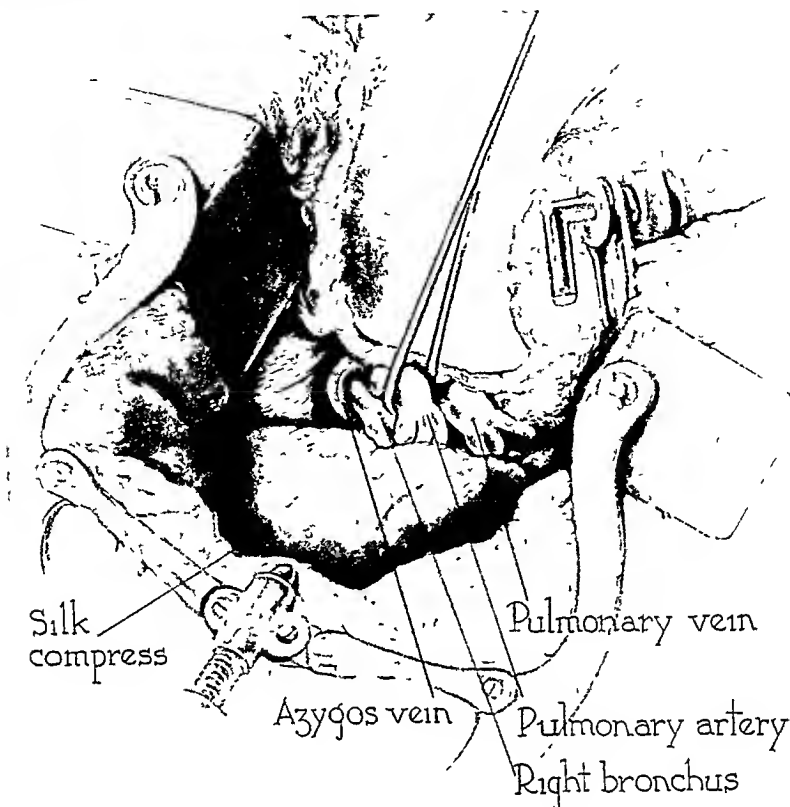


Fig 16 Diagrammatic illustration of futility of mass ligation and necessity of high section of bronchus as exemplified in authors' first case. Although individual ligation of hilar structures was done the bronchus was divided insufficiently high to include the tumor. The pathologist who was present at the operation observed absence of tumor before mediastinal wound was closed, permitting further dissection of bronchus up to carina and high removal of bronchus to include tumor.



*See Morel.*

Fig 15 Drawing showing individual isolation of pulmonary artery, pulmonary vein, and bronchus in anterior approach for pneumonectomy

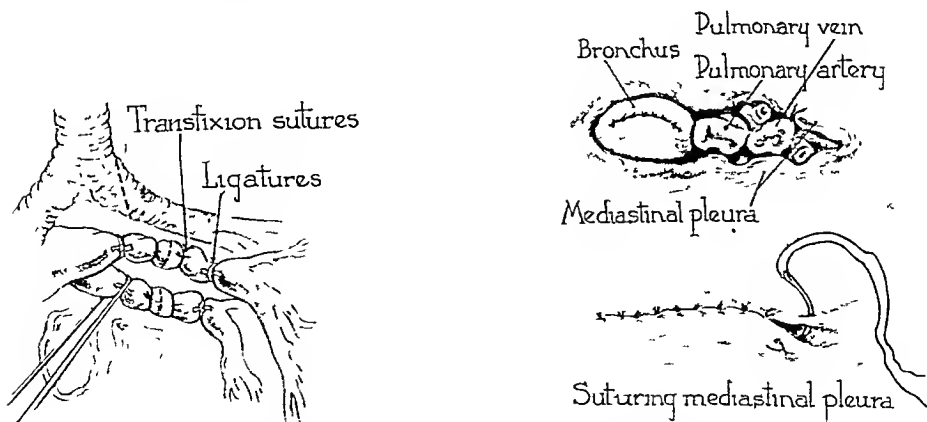


Fig 17 Diagrammatic illustration of technique which is employed in individual isolation of hilar structures. Division of the pulmonary artery and of the pulmonary veins is performed between double ligation and transfixion sutures.

Fig 18 Drawing showing pleuralization of mediastinum following complete extirpation of all mediastinal lymph nodes. The edges of the divided mediastinal pleura are approximated covering the stump of the ligated vessels and bronchus with pleura.

TABLE I—SUMMARY OF REPORTED AND AUTHORS CASES OF PNEUMONECTOMY FOR PULMONARY NEOPLASMS

Author and ref.	Date of operation	Date of report	Lesion	Age	Location					Sex	Location	R	D	Length of life	Comments
					R	I	U	L	M						
Kuehnelt	(11)	10-10-1917	Carcinoma	48	+					F	Mass		+	6 days	Discharge of lung meta-asthma at time of operation
Meyer	(12)	4-26-20	Lymph sarcoma	5	+					M	Mass		+	10 days	Edema of lung
Thoma	(7)	11-8-1923	Carcinoma	57		+		+		F	Inf. lobe		+	6 days	Lung some of metastases and other lung
Archbell	(5)	12-31-1922	Carcinoma	32		+				M	M		+	days	Streptococcal septicemia and pulmonary edema
Lechvald	(13)	2-2-33	Sarcoma	31		+	+			M	Mass		+	5 mos.	1 year
Barber	(10)	3-6-42 (1942)	Carcinoma	4		+				M	Inf. lobe		+	41 days	Edema and bronchopneumonia
Ivanovich and Fein	(12)	10-11-33	Carcinoma	45		+	+			M	Inf. lobe		+	8 days	Carcinoma failure pulmonary metastases
Thomson	(17)	2-23-1933	Terminally sarcoma from bronchus	33		+		+		F	Mass		+	4 days	Bronchopneumonia
Chahama and Singer	(13)	4-5-33	Carcinoma	48		+		+		M	Mass		+		
Graham	(14)	1936	Carcinoma										+	1 week	Pneumonia
Graham	(14)	1936	Carcinoma										+	1 week	Pneumonia
Graham	(14)	1936	Carcinoma										+		Cerebral metastases
Rienhoff	(17)	24-15-1931	Sarcoma	3		+				F	Inf. lobe		+		
Pienhoff	(17)	3-31-1931	Bronchogenic carcinoma	52		+				F	Inf. lobe		+		
Rienhoff	(17)	1931											+		
Rienhoff	(17)	1931											+		
Rienhoff	(17)	1931											+		
Rienhoff	(17)	1931											+	5 days	
Rienhoff	(17)	1931											+	6 weeks	
Rienhoff	(17)	1931											+	6 mos.	Metastases
Friedlander (Case 1)	(10)	11-4-33	Lung cancer	44		+		+		M	Inf. lobe		+	1 day	Emphysema and bronchopneumonia
Friedlander (Case 3)	(10)	10-3-33	Carcinoma	45		+		+		M	Mass		+	1 m	Emphysema metastases
Friedlander (Case 4)	(10)	8-10-33	Carcinoma	4		+		+		F	Inf. lobe		+		
Friedlander (Case 5)	(10)	1-1-34	Carcinoma	4		+	+			M	Inf. lobe		+		Pulmonary edema emphysema and metastases
Friedlander (Case 7)	(10)	3-1-34	Carcinoma	30		+		+		M	Inf. lobe		+	125 days	Emphysema and bronchopneumonia
Cheroff and Thoma (Case 1 in R. 144)	(13)	3-34-35	Carcinoma	53		+				F	Mass		+		

Key: R—right lobe L—left lobe U—upper lobe I—lower lobe M—middle lobe R—recovered R—red

Indicates involvement of other lobes

Indicates rapid removal of tumor

The patient died because of metastases

TABLE I—SUMMARY OF REPORTED AND AUTHORS' CASES OF PNEUMONECTOMY FOR PULMONARY NEOPLASMS—Continued

Author and ref	Date of operation	Date reported	Lesion	Age	Location					Sex	Ligation	R'	D	Length of life	Cause of death
					R	L	U	L'	M						
Overholt (Case 2) (44)	5-2-34	1935	Carcinoma	42		+		+		F	Mass	+			
Overholt (Case 3) (44)	7-7-34	1935	Carcinoma†	43		+				M	Mass		+	48 hrs	Severe pulmonary hemorrhage
Overholt (Case 5) (44)	11-13-34	1935	Carcinoma†	37		+				M	Mass		+	Operation	Hemorrhage
Overholt (Case 6) (44)	12-8-34	1935	Carcinoma	50	+				+	M	Mass		+	6 days	Pneumonia
Overholt (Case 8) (44)	4-8-35	1935	Carcinoma	59		+	+			F	Individual	+			
Overholt (45)		1938	Carcinoma										+		
Overholt (45)		1938	Carcinoma									+			
Overholt (45)		1938	Carcinoma									+			
Overholt (45)		1938	Carcinoma									+			
Overholt (45)		1938	Carcinoma									+			
Edwards (16)		1934	Carcinoma		+					M	Mass		+	16 days	Emphysema, pericarditis, bronchial fistula
Edwards (16)		1934	Carcinoma		+						Mass		+	3 days	Cardiac failure
Edwards (17)												+			
Edwards (17)												+			
Edwards (17)												+			
Edwards (17)													+		
Alexander (1)	11-6-33	1935 1936	Carcinoma			+							+	30 days	Cardiac failure
Flick and Gihbon (19)	6-13-34	1936	Carcinoma	46		+	+			M	Individual		+	2 mos	Metastasis
Duval and Monad (15)	2-14-35	1935	Carcinoma	59	+				+	M			+	Operation	Mediastinal metastasis to rt auricle
Lyle (38)	2-20-35	1936	Carcinoma	61	+				+	F	Individual	+			
Lambert (35)	3-19-35	1935	Carcinoma	59		+	+			M	Individual		+	18 hrs	Shock and hemorrhage
Santy et al (Case 2) (50)	10-7-35	1936	Carcinoma	45		+	+			M	Mass		+	8 days	Pulmonary congestion
Frissel and Knox (21)	2-20-35	1937	Carcinoma†	64	+					M		+		6 mos	
Haight (25)		1935	Carcinoma			+						+			
Arce (3)		1936	Carcinoma										+	8 hrs	
Arce (3)		1936	Carcinoma										+	48 hrs	Thrombus rt heart
Arce (3)	9-15-36	1936	Metastatic melanoma	27		+			+	F		+			
Arce (4)		1938									Tamponade		+		
Arce (4)		1938									Tamponade		+		
Arce (4)		1938									Tamponade		+		
Arce (4)		1938									Tamponade		+		
Arce (4)		1938									Tamponade		+		
Arce (4)		1938									Tamponade		+		
Churchill (10)		1935										+			

Key: R—right lobe, L—left lobe, U—upper lobe, L'—lower lobe, M—middle lobe, R'—recovered, D—died

\*Indicates involvement of entire lung

†Indicates involvement of hilar region

‡The patients died subsequently of metastases or other causes



TABLE I—SUMMARY OF REPORTED AND AUTHORS CASES OF PNEUMONECTOMY FOR PULMONARY NEOPLASMS—Concluded

Author and ref	Date of operation	Date reported	Lesion	Age	Location					Sex	Location	R	D	Length of life	Cause of death
					R	L	U	L	M						
Churchill (12)		1937	1									+			Metastasis
Churchill (12)		1937	2									+			Metastasis
Churchill (12)		1937											+		
Churchill (12)		1937											+		
Churchill (12)		1937											+		
Holst (19)		1937	Carcinoma	52						F			+	8 days	Empyema
Crafoord (Case 1)	(1)	7-9-34	1935	Carcinoma	26	+			+	F	Individual		+	Day of operation	Hemorrhage at pleural cavity
Crafoord (Case 2)	(12)	9-16-35	1935	Carcinoma	45		+	+		M	Individual		+	7 wks.	Lung abscess—operative drainage
Crafoord (Case 3)	(12)	3-16-36	1935	Carcinoma	31	+			+	M	Individual		+	1 day	Thrombosis and embolism of carotid artery
Crafoord (Case 4)	(11)	4-21-36	1935	Carcinoma	46		+			M	Individual		+		
Crafoord (Case 5)	(12)	6-16-36	1935	Carcinoma	44	+			+	M	Individual		+	6 days	Empyema and mediastinitis
Crafoord (Case 6)	(11)	9-3-36	1935	Carcinoma	50	+			+	M	Individual		+	3 d 7 w	Thrombosis and embolism of pulmonary artery
Crafoord (Case 7)	(11)	8-12-37	1935	Carcinoma	47		+		+	F	Individual		+	11 days	Atelectasis and pulmonary edema
Crafoord (Case 8)	(11)	8-16-37	1935	Carcinoma	50		+		+	M	Individual		+	8 mos.	Cardiac failure pneumonia
Crafoord (Case 9)	(11)	9-19-37	1935	Carcinoma	63		+		+	M	Individual		+	36 hrs.	Pulmonary edema
Crafoord (Case 10)	(11)	11-14-37	1935	Carcinoma	50	+			+	M	Individual		+		
Crafoord (Case 11)	(12)	1-25-38	1935	Carcinoma	50		+		+	M	Individual		+		
Crafoord (Case 12)	(1)	3-2-38	1935	Carcinoma	50	+			+	M	Individual		+	1 day	Atelectasis and bronchitis
Matsu et al (4)		3-5-38	1935	Carcinoma	36	+			+	M	Mammary		+	6 days	Empyema bronchopleural fistula—fatal hemorrhage from a pulmonary vein
Ochsner and DeBakey (Case 1—W R)		4-15-38		Fibrous scar?	39	+				M	Individual		+		
Ochsner and DeBakey (Case 2—H D R)		6-23-37 6-26-37 (1938)		Carcinoma	47	+			+	M	Individual		+	Operative	Hemorrhage from azygos vein
Ochsner and DeBakey (Case 3—R J)		7-8-37		Carcinoma	4	+			+	F	Individual		+	10 days	Pneumonia—peritonitis—nodules
Ochsner and DeBakey (Case 4—F P)		4-26-38		Carcinoma	62	+			+	M	Individual		+	1 hr	Asphyxia
Ochsner and DeBakey (Case 5—S B)		8-23-38		Carcinoma	45	+			+	F	Individual		+	14 hrs.	Pulmonary edema
Ochsner and DeBakey (Case 6—F E)		9-10-38		Carcinoma	32		+	+		M	Individual		+	5 days	Cardiac failure
Ochsner and DeBakey (Case 7—A J)		10-6-38		Carcinoma	58	+			+	M	Individual		+		

key R—right lobe L—left lobe U—upper lobe L—lower lobe M—middle lobe R—recovered D—died  
 Ind. indicates involvement of entire lung  
 † indicates involvement of both lungs  
 See footnote under A. also of Cases

‡ The patient died a frequent victim of metastases or other causes.

## REFERENCES

- 1 ALEXANDER, J Personal communication to Haight Surg, Gynec & Ohst., 1934, 58, 768
- 2 Idem. Observations on total pulmonary lobectomy and pneumonectomy. *Ann Surg*, 1935, 101, 393
- 3 ARCE, M J. Pneumectomie totale (Le tampon-drainage en chirurgie endothoracique). *Mém Acad de Chir*, 1936, 62, 1412
- 4 Idem. Tratamiento quirurgico de los quiste y tumores del pulmón (metodos y procedimientos generales) *Soc Internat de Chir*, 11th Congress, Sept., 1938
- 5 ARCHIBALD, E The technique of total unilateral pneumonectomy *Ann Surg*, 1934, 100, 796
- 6 BIGGER, I A The diagnosis and treatment of primary carcinoma of the lung *South Surg*, 1935, 4, 401
- 7 BINKLEY, J S Aspiration biopsy of lung. Presented at 21st annual meeting of the Am Soc Thoracic Surg, 1938 (in press)—*J Thoracic Surg* Reviewed by I. A. Bigger, *Surgery*, 1938, 4, 307.
- 8 BONNIOT, MONOD, O, and EVRARD, H Considérations anatomiques pour servir à l'abord des pédicules pulmonaires par voie antérieure *J de chir*, 1936, 48, 173
- 9 BOYD, W Pathology of primary carcinoma of the lung *Canadian M Ass J*, 1930, 23, 210
- 10 CHURCHILL, E D Discussion of Overholt's paper. *J Thoracic Surg*, 1935-36, 5, 80
- 11 Ibid Lobectomy and pneumonectomy in bronchiectasis and cystic disease 1936-37, 6, 286
- 12 CRAFTOORD, C On the Technique of Pneumonectomy in Man *Stockholm Tryckin Aktiebolaget Thule*, 1938
- 13 D'AUNOY, R, PEARSON, B, and HALPERT, B Personal communications
- 14 DUDGEON, L S, and WRIGLEY, C H On demonstration of particles of malignant growth in sputum by means of wet-film method *J Laryngol & Otol*, 1935, 50, 752.
- 15 DUVAL, P, and MONAD, R Discussion of Lambret's paper Pneumectomie totale pour cancer du poumon gauche *Bull et mém Soc nat de chir*, 1935, 61, 813
- 16 EDWARDS, A T Malignant diseases of the lung *J Thoracic Surg*, 1934-35, 4, 107
- 17 Idem Quoted by Crafoord, Ref No 12
- 18 FISCHER, W In Henke and Lubarsch *Handbuch der speziellen pathologischen Anatomie und Histologie* Berlin Springer, 1931, 3, 3, 509
- 19 FLICK, J B, and GIBSON, J H, JR Total removal of the left lung for carcinoma *Ann Surg*, 1936, 103, 130
- 20 FREEDLANDER, S O Total pneumonectomy *Ohio State M J*, Columbus, 1937, 33, 769
- 21 FRISSEL, L E, and KNOX, J C. Primary cancer of the lung *Am J Cancer*, 1937, 30, 219
- 22 GOLDMAN, ALFRED Cytology of serous effusions, with special reference to tumor cells *Arch Surg*, 1929, 19, 1672
- 23 GRAHAM, E A, and SINGER, J. J Successful removal of an entire lung for carcinoma of bronchus *J. Am M Ass*, 1933, 101, 1371
- 24 GRAHAM, E A Primary carcinoma of the lung or bronchus *Ann Surg*, 1936, 103, 1
- 25 HAIGHT, C From discussion on "Pneumonectomy for malignant and suppurative disease of the lung," by R Overholt *J Thoracic Surg*, 1935-36, 5, 77
- 26 HALPERT, B Pathology of bronchogenic carcinoma *N Orleans M & S J* (in press)
- 27 HINZ, R Totale extirpation der linken Lunge Wegen bronchial Carcinom *Arch f klin. Chir*, 1923, 124, 104
- 28 HOLINGER, P Personal communication
- 29 HOLST, J. Lobektomi og pulmektomi ved bronchiektosi Förhandl ved nord Kirurg Forenings moete, 1937, 411, 415
- 30 IVANISSEVICH, O, and FERRARI, R C La pneumectomie en el hombre *Bol y trab Soc de cirug de Buenos Aires*, July 5, 1933, 17
- 31 JACKSON, C W C, and KONZELMANN, F W Bronchial carcinoma, bronchus biopsy in a series of 32 cases *J Thoracic Surg*, 1935-36, 4, 165
- 32 JAFFÉ, R H Primary carcinoma of lung *J Lab & Clin Med*, 1935, 20, 1227
- 33 JUNGHANS, H Der Krebs der Lungen bronchien und oheren luftwege *Ztschr f Krebsforsch*, 1929, 28, 573
- 34 KUEMMEL, H Discussion of W Mueller Demonstration zur extirpation ganzer Lungenlappen. *Verhandl d deutsch Gesellsch f Chir*, 1911, 40, 147.
- 35 LAMBRET, M O Pneumectomie totale pour cancer du poumon gauche *Bull et mém. Soc nat de chir*, 1935, 61, 804
- 36 LANFORD, J A Personal communication
- 37 LILIENTHAL, H Pneumonectomy for sarcoma of the lung in a tuberculous patient *J Thoracic Surg*, 1932-33, 2, 600
- 38 LYLE, H H M Carcinoma of the right lung Pneumonectomy in one stage *Ann Surg*, 1936, 103, 124
- 39 MANDLEBAUM, F S Quoted by Goldman, Ref No 22
- 40 MARTIN, H E, and ELLIS, E B Biopsy by needle puncture and aspiration. *Ann Surg*, 1930, 92, 169
- 41 MATSON, R C, ROBERTS, J M, and BISAILLON, M Total removal of the right lung for bronchogenic carcinoma *Dis of the Chest*, 1938, 4, 43.
- 42 MEYER, W. Observations in lung suppuration and its treatment *Arch Surg*, 1923, 6, 361
- 43 OVERHOLT, R H The total removal of right lung for carcinoma—report of a successful case *J Thoracic Surg*, 1934-35, 4, 196
- 44 Ibid Pneumonectomy for malignant and suppurative diseases of the lung *J Thoracic Surg*, 1935-36, 5, 54
- 45 Idem Clinical studies and treatment of primary carcinoma of the lung *J. Connecticut Med Soc*, 2, 122, 1938
- 46 RIENHOFF, W F, JR The treatment of carcinoma of the lung *Surg Clin N America*, 1936, 16, 1459
- 47 Idem. Pneumonectomy A preliminary report on the operative technic in two successful cases *Bull Johns Hopkins Hosp*, Balt., 1933, 53, 390
- 48 Idem The surgical technic of total pneumonectomy *Arch Surg*, 1936, 32, 218
- 49 Idem Intrathoracic anatomical readjustments following complete ablation of one lung *J Thoracic Surg*, 1937, 6, 254
- 50 SANTY, BONNIOT, DARGENT, CORAJOD, and BERARD Lobectomie et pneumectomie pour neoplasmes bronchopulmonaires *Lyon méd*, 1936, 157, 485 and 521
- 51 SEYFARTH, C Lungenkarzinom in Leipzig *Deutsche Med Wchnschr*, 1924, 50, 1497
- 52 SHARP, G The diagnosis of primary carcinoma of the lung by aspiration *Am J Cancer*, 1931, 15, 853
- 53 WINTERITZ, M A, WASON, I M, and McNAMARA, F P The Pathology of Influenza *New Haven-Yale University Press*, 1920

# EVALUATION OF OVARIAN STERILIZATION FOR BREAST CANCER

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**I**N June, 1935, Dresser reported our experience at the Collis P Huntington Memorial and Pondville State Hospitals with ovarian radiation in cases of carcinoma of the breast with bone metastases. Following the policies he reported, we have continued to carry out artificial menopause in recurrent and inoperable cases at these hospitals, and in addition have offered and employed the procedure prophylactically after radical mastectomy in young women. Thus we are able to present briefly an additional series of 50 cases of therapeutic artificial menopause in which patients were treated between January, 1935, and April, 1937.

## THERAPEUTIC ARTIFICIAL MENOPAUSE

These patients varied greatly on admission in the extent and stage of the disease. Many were advanced, untreated cases; others presented lesions otherwise operable in whom x ray examination detected early metastatic involvement; still others represented recurrent disease locally or metastatically, after radical or subradical surgery. It is difficult to reduce such a group to a common basis for analysis. Twenty patients showed possible or probable benefit from the procedure. In many cases, when the focus of disease could be radiated, the regression may have been due in part to the local radiation rather than to the menopause. This applies particularly to recurrent nodules in the operative area or to supraclavicular lymph node metastases in which local radiation is found to be particularly effective.

Among the 20 patients with probable or possible benefit, 9 patients showed regression of bone metastases of greater or lesser extent ranging from complete regression and recalcification to a change from osteoclastic to osteoblastic bone lesions. Six patients with recurrence in the operative area or supraclavicular area showed marked improvement, but again it must be emphasized that these cases also had the benefit of intensive local x ray therapy. One patient with pleural effusion and another with ascites were relieved

of the necessity of frequent paracenteses. There was apparent regression of pulmonary metastases in 1 instance. Finally, in 2 patients with rather widespread involvement, the progress of the disease seemed to be definitely arrested, in 1 patient for several months and in the other for a period of about 2 years.

Of the entire group of 50 cases, 42 patients are dead, 1 remains untraced and 7 are still living without evident active progress of the disease.

## CASE REPORTS

**CASE 1.** No 10707. The patient aged 43 years had a radical mastectomy performed in October 1933. She was admitted in April 1936 bedridden with generalized skeletal metastases. Artificial menopause was employed in May 1936. Reports by letter dated November 1937 state that she is up and about, driving an automobile, doing house work and feeling better than she has in years.

**CASE 2.** No 10130. This patient who was 50 years of age had a radical mastectomy performed in June 1932. The axillary nodes were involved. There was a supraclavicular node recurrence in November 1935 when artificial menopause and local x ray treatment were employed. In January 1938 no evidence of active disease was seen but there was paralysis of the left vocal cord.

**CASE 3.** No 8132. The patient aged 37 years had carcinoma of the breast and axilla with cranial metastases. Radical mastectomy to breast and axilla was applied in May 1933. Artificial menopause was employed in October 1933 and complete regeneration of cranium was observed in March 1935. New cranial metastases involving orbit occurred in May 1937. Her condition was unchanged but there were no further symptoms in October 1937.

**CASE 4.** No 4950. The patient 42 years of age had a radical mastectomy performed in December 1931. The axilla was not involved. She received postoperative x ray therapy. In December 1934 there was a recurrence in lung and mediastinum. Probably spontaneous menopause had occurred in 1933. She received pelvic radiation in February 1935 and in June 1938 there was no evident disease. Chest x ray was unchanged and there was no evidence of radiation fibrosis.

**CASE 5.** No 35-949. The patient aged 35 years had a simple mastectomy performed in May 1935. There was a recurrence in the scar in August 1935 and local x ray treatment was used. Artificial menopause was employed in December 1935. In February 1936 there was a local recurrence plus axillary nodes for which local x ray treatment was applied. Menstruation returned in October 1936 when she received additional x ray treatment to pelvis. In March 1938 there was no evidence of disease.

**CASE 6.** No 33-1540. Biopsy was performed in 1929 upon the patient 34 years of age and radical mastectomy followed 2 weeks later. There were local recurrences in April, 1933 which were excised. Multiple skin nodules axillary and supraclavicular metastases appeared in December 1933 and she received local x ray therapy. Art

From the Collis P Huntington Memorial and Pondville State Hospitals.

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TABLE I —AXILLARY INVOLVEMENT ON ADMISSION

	Age	
	Under 46 Per cent	Over 60 Per cent
Axilla not involved	23	43
Axilla involved	77	57

ficial menopause was employed in April, 1934. There was no evidence of disease in August, 1938.

CASE 7. M. C., aged 33 years, had a radical mastectomy performed in April, 1927. The axillary nodes were involved. Pleural metastases appeared in 1933 and there were recurrences in the scar tissue in 1934. Local x-ray therapy was applied with multiple thoracenteses. Artificial menopause was employed in 1935, and further thoracenteses were unnecessary. In August, 1938, she was troubled with cough and dyspnea, but x-ray findings were unchanged. There was some question of pulmonary fibrosis.

It is of interest to compare the present group with other published series of cases. Dresser found benefit in about a third of his cases. Ahlborn reported that about 70 per cent of his cases were improved, but he made no attempt to rule out the benefit attributable to local radiation therapy. Most of the scattered individual case reports record benefit to patients with bone metastases. Regression of pulmonary or visceral metastases are rarer, although Dresser reported a case of regression of pulmonary metastases. Skin and scalp nodules have disappeared in some cases, even when no local therapy is employed. The regression noted by earlier advocates of surgical menopause, Schinzinger, Beatson, Thomson, Lett, and others, was limited to the demonstrable superficial lesions. The authors also reported improvement in about one third of the cases subjected to castration. We are unaware of any cases of regression of liver or brain metastases. Inflammatory carcinoma does not often show notable benefit following artificial menopause (10).

Many of the patients, who are to benefit by the procedure, experience a marked improvement in their sense of well-being. Often they gain in weight and appetite, simultaneously with the arrest in progress of the disease. This general improvement occurs in favorable cases in spite of the existence of the menopausal symptoms which, in these patients, are often particularly troublesome.

We may conclude that as a therapeutic procedure, artificial menopause is of definite palliative benefit to about one-third of the patients with inoperable or recurrent carcinoma of the breast. The most striking and, in most instances, the most durable results are evident in the group suffering from osseous metastases. While ade-

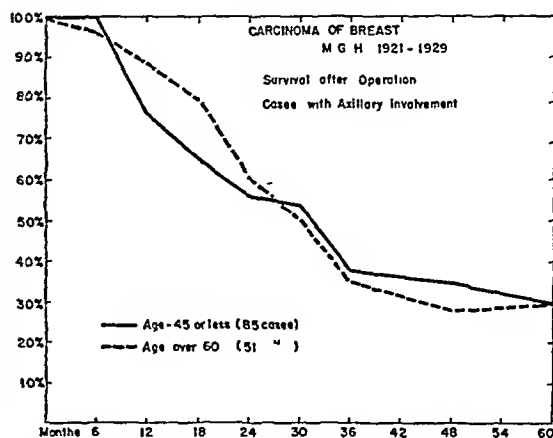


Chart 1. Carcinoma of the breast, Massachusetts General Hospital, 1921-1929, survival after operation, cases with axillary involvement.

quate data are lacking, it is probable that life is prolonged in many of the patients. It is unlikely that patients with visceral metastases benefit very often from the procedure. We have observed no such encouraging cases, as those reported by Clarkson and Barker, in which apparent cure resulted from artificial menopause combined with intensive local x-ray therapy. In general it is fair to say that the benefit is transitory and capricious, although the occasionally gratifying results and the virtually negligible inconvenience would seem to justify the procedure in young women who are suffering from incurable disease.

#### PROPHYLACTIC ARTIFICIAL MENOPAUSE

Encouraged by the results in recurrent and inoperable disease, we have employed artificial menopause as a prophylactic procedure in young women following radical mastectomy for operable carcinoma of the breast. Forty-seven of these cases are available for study, of which 14 patients had no axillary node metastases, while 33 presented positive axillary nodes. Of the early and favorable cases 1 patient died of liver and cerebral metastases, and the 13 remaining are living, apparently free from disease for an average

TABLE II —PATHOLOGICAL GRADE OF MALIGNANCY

	Age	
	Under 46 146 Per cent	Over 60 156 Per cent
Grade I	7	16
Grade II	49	56
Grade III	44	28

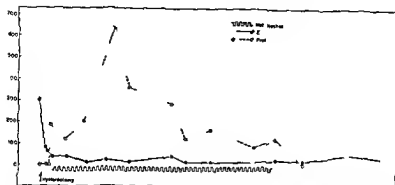


Chart 2 Surgical menopause Hysterectomy and bilateral oophorectomy Solid line urinary estrin excretion in international units dotted line urinary prolactin excretion in mouse units

period of 2.8 years after operation. Of the 33 patients with axillary involvement 15 are dead, 3 are living with probable recurrence and 15 are living without evidence of disease for an average period of 2.7 years after operation.

Obviously it is premature to attempt any appraisal of the value of artificial menopause in this group. Accurate knowledge of the expected results must be available in a comparable group of radical operations in young women without artificial menopause. Such a study was carried out and reported in 1936 (11), in which 5 year end results in a group of young women were contrasted with results in older women. Briefly it was demonstrated that carcinoma of the breast tends to metastasize earlier in young women that it tends to be of higher grade of malignancy and that postoperative recurrence takes place a little more promptly. These findings are pre-

sented in Tables I and II and Chart 1. As a result of the study it was concluded that in carcinomas of the breast of equivalent extent and of equal grade of malignancy age alone does not affect curability (Table III).

Reverting to Chart 2, it can be seen that the curve of survivals of both age groups is close to 50 per cent at the end of 30 months after operation. This corresponds to the figure for our artificial menopause group with axillary metastases at an average interval of 2.7 years after operation. Obviously, the curve for the artificial menopause group may flatten out hereafter, although from the chart it can be seen again that from this point onward the young and old groups run parallel courses. Hence it may be concluded that we have thus far observed nothing in our study to warrant the conclusion that artificial menopause is likely to be of striking benefit as a prophylactic procedure against recurrence after radical mastectomy.

We turn to the laboratories and hormonal studies for an explanation of the benefits which do take place in some of the recurrent cases. Studies of estrin and prolactin A, or the follicle stimulating hormone levels in carcinoma of the breast cases show no significant differences from levels in control individuals. The effect of artificial menopause on these levels is illustrated in Charts 2, 3 and 4 (7).

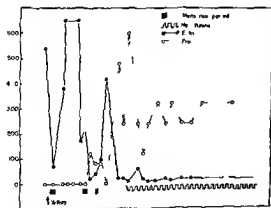


Chart 3 Successful radiation menopause Solid line urinary estrin excretion in international units dotted line urinary prolactin excretion in mouse units

TABLE III — CURES WITH RADICAL OPERATIONS

Cases	Age	
	Under 45	Over 45
	117	113
	Per cent	Per cent
Cures	34	44
Axilla not involved	71	67
Axilla involved	20	21

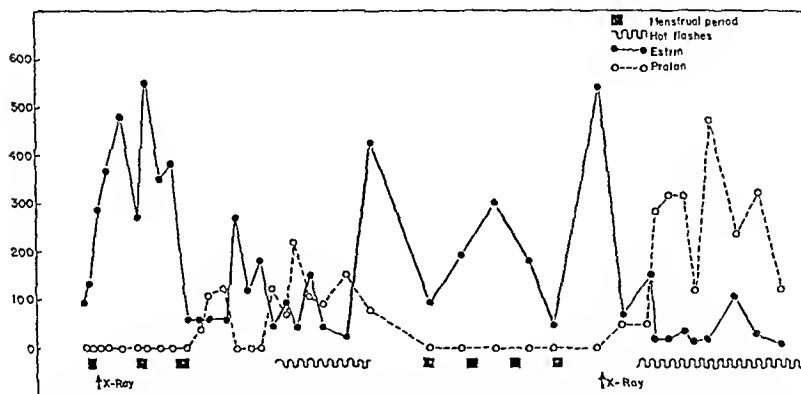


Chart 4 Unsuccessful radiation menopause Solid line urinary estrin excretion in international units, dotted line urinary prolactin A excretion in mouse units

Note that in the case of oophorectomy (Chart 2), the estrin level falls at once to a low level where it remains. This is accompanied by a rapid rise in the prolactin A excretion, accompanied by hot flashes. The successful radiation menopause (Chart 3), shows similar curves, although the response is not so prompt. In the case of inadequate radiation (Chart 4), note that the estrin does not fall to the low menopausal level, but that it shows marked irregularities. Resumption of menses is heralded by a marked rise in the level of estrin and by a sharp drop in prolactin A.

Are we justified in assuming that the benefits observed in certain of the cases are due to the low estrin level obtained, either directly or through the compensatory response of the anterior pituitary hormones? Are we concerned with the effect of estrin on the calcium metabolism in accounting for the regressions of bone metastases? These are questions which cannot be answered authoritatively on the basis of available knowledge. It seems, in these cases which show favorable response to menopause, as if the tumor growth is unusually dependent on the presence of considerable amounts of estrin, and that removal of this growth stimulus temporarily results in retardation or actual regression in the disease.

The experimental work of Lacassagne, Loeb, his co-workers, and others, prepares us to accept the etiological significance of estrin in carcinoma of the breast. As far as we are aware, none of the experimental work justifies the assumption that growth of the tumor is dependent on a continuance of estrin stimulation after the development of malignancy has once taken place. If this assumption be correct, it seems unnecessary to point out that the menopausal symptoms, which

may take place, should not be treated by the administration of estrin.

We turn to the pathologists in vain for a definition of characteristics of the growth which would indicate a likelihood of favorable response. Until they can do so, we must continue to give the possible advantage to all cases of recurrent and inoperable disease, with the reasonable hope that a certain number of the patients will benefit as a result.

#### CONCLUSIONS

Artificial menopause may be expected to result in temporary regressions or improvement in about one-third of the cases with recurrent and inoperable carcinoma of the breast. The most striking benefit appears to accrue in cases with osseous metastases.

Artificial menopause cannot be demonstrated as advantageous when employed as a prophylactic procedure in patients who are submitted to radical operation.

Hormone studies are thus far unable to explain why the favorable effects take place; and pathological studies are unable to predict which cases will react favorably.

#### BIBLIOGRAPHY

1. AHLBOM, H. Castration by roentgen rays as an auxiliary treatment in the radiotherapy of cancer mammae at Radiumhemmet, Stockholm. *Acta Radiol*, 1930, 2, 614-633.
2. BEATSON, G. T. The treatment of inoperable carcinoma of the female mamma. *Glasgow M J*, 1911, 76, 81-87.
3. CLARKSON, W., and BARKER, A. Five year cure of mammary carcinoma with multiple metastases to bone. *Am J Roentgenol*, 1936, 36, 615-621.
4. DRESSER, R. The effect of ovarian radiation on the bone metastases of cancer of the breast. *Am J Roentgenol*, Mar, 1936, 35, 384-388.

- 5 LACASSAGNE A Hormonal pathogenesis of adeno carcinoma of the breast *Am J Cancer* June 1936 27 2 217-228
- 6 LEE H An analysis of 99 cases of inoperable carcinoma of the breast treated by oophorectomy *Lancet*, 1905 1 227-228
- 7 NATHANSON I T et al To be published
- 8 SCHINZINGER Das Karzinom der Mamma Muenchen med Wchschr 1905 52 1724-1725
- 9 SUNTZEFF V BURNS L L, MOSKOF M and LOES I The effect of injections of estrin on the incidence of mammary cancer in various strains of mice. *Am J Cancer* June 1936 27 2 229-245
- 10 TAYLOR G W and MELTZER A Inflammatory carcinoma of the breast *Am J Cancer*, 1934 31 33
- 11 TAYLOR G W Carcinoma of the breast in young women *New England J Med* Dec 31 1936 215 27 1376
- 12 THOMPSON, A Analysis of cases in which oophorectomy was performed for inoperable carcinoma of the breast *Brit M J*, 1902 2 1538-1541

# PALLIATIVE IRRADIATION OF METASTATIC TUMORS IN THE LUNGS

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THE rather limited literature on irradiation therapy of pulmonary metastases has been reviewed recently by Treves. This author also cites 38 cases from the Memorial Hospital, New York, of pulmonary metastases from breast carcinoma, which were treated by irradiation, and compares them with 21 similar cases that did not receive such treatment. The average duration of life after treatment was 11.4 months whereas in the untreated cases it was 35.9 months. While isolated instances of improvement following irradiation therapy are admitted, the general conclusion is, that with rare exceptions, roentgenotherapy is of doubtful value in controlling mammary cancer which has invaded the lung.

This report includes the results obtained by irradiation of pulmonary metastases from various types of primary growths outside the thorax observed in 13 cases of the University of Chicago Clinics. These are summarized in the accompanying table.

In every case there was histological verification of the nature of the primary tumor. The diagnosis of metastatic pulmonary lesions was based upon roentgenographic appearances of the chest and in every instance, except in Case 5, the lesions were discrete, rounded masses and not diffuse shadows which are always more questionable. Necropsy was obtained in the majority of patients who died confirming the roentgenographic diagnosis.

Additional reports, not included in Treves' review, are those of Hohlfelder of a patient with pulmonary metastases from thyroid carcinoma who survived 8 years, Schulte reports a case of pulmonary metastases from Ewing sarcoma which regressed completely from the roentgenographic standpoint following irradiation, the patient dying 2 years later of sarcomatosis, and Fussl reports a case of thyroid carcinoma metastases which regressed after irradiation and the patient survived 4½ years.

From the Department of Surgery and the Division of Roentgenology of the Department of Medicine, University of Chicago Clinics.

Presented in the Symposium on Cancer, before the Clinical Congress of the American College of Surgeons, New York, October 17-21, 1938.

Case number 523 in the Bone Sarcoma Registry is a white female presenting an advanced sarcoma of the left ilium in 1922, which was treated by irradiation. In the same year roentgenographic evidence of advanced metastases in both lungs was observed and the chest irradiated. The metastases disappeared and when last seen in 1938, 16 years later, the lungs were clear and there was no evidence of active disease.

## ANALYSIS OF SERIES

In the series of 13 cases shown in Table I, complete, immediate regression of the metastases from the roentgenographic standpoint was observed in 9 instances. Five of these 9 patients died in 3 months to 1 year of carcinomatosis including recurrences in the lungs. Of the 4 patients remaining, 3 are alive 19 months, 21 months, and 7 years respectively, without roentgenographic evidence of active neoplasm in the lungs, and 1 died 18 months after treatment of an intercurrent complication, but at necropsy no evidence of malignant tumor was present at the site of metastasis, that is, in the mediastinum.

*Dosage.* Experience has shown that pulmonary metastases often exhibit a marked degree of radiosensitivity, even greater apparently than the primary growth. The explanation for this of course remains obscure but some of the factors may be vascularity and difference in "soil." The calculated tumor doses, employed in the series here reported, vary widely, and it is interesting to note that the small to moderate doses were as effective as the large doses.

*Technique.* The technique employed was as follows: 200 kilovolts, 5 to 1 millimeter of copper, plus 1 millimeter of aluminum filtration 5 to 25 milliamperes, 50 to 80 centimeters FSD, 10 by 10 centimeter to 20 by 20 centimeter ports on the anterior and posterior chest walls depending on number and size of lesions. Only the affected lungs were treated; the whole chest was exposed only when the metastatic lesions were bilateral.

No attempt is made to include all cases of pulmonary metastases treated, and to arrive at some mathematical expression of the probability of regression or prolonged survival following treat-



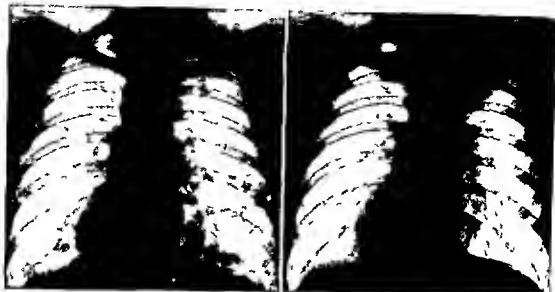


Fig. 1 Roentgenograms of chest showing extensive pulmonary metastases from embryonal carcinoma of testis before October 1, 1934 and November 23, 1938 after x ray

therapy. Patient died 4 months later of generalized metastases but the case illustrates the phenomenal regressions that sometimes obtain in very radiosensitive tumors.



Fig. 2 Roentgenograms of chest of patient with Ewing sarcoma of the pelvis and large pulmonary metastasis in right lung. The primary lesion was treated by means of irradiation and 6 months later when these roentgenograms

were taken the metastatic lesion was similarly treated and this therapy was followed by complete regression. The patient is free from evidence of active disease 24 months later.

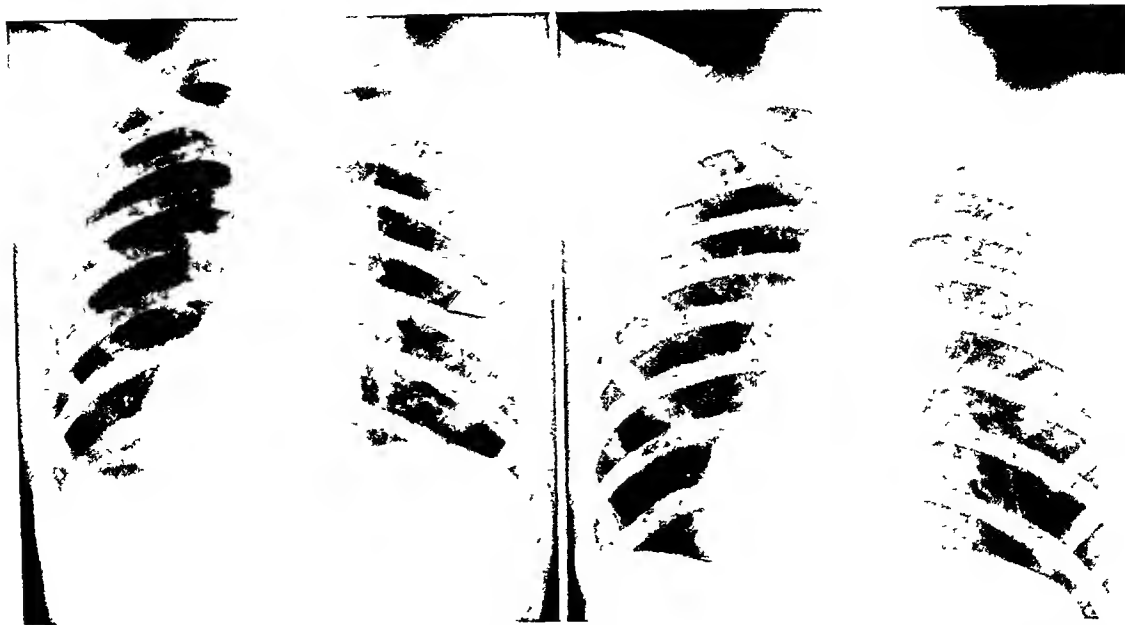


Fig 3 Roentgenograms of chest of patient with Ewing sarcoma of pelvis and solitary metastatic mass in right lung. The primary lesion was treated by means of irradiation as was the pulmonary lesion 6 months later. There was

complete regression of the pulmonary lesion following treatment, and 21 months later the patient remained free from evidence of active disease.

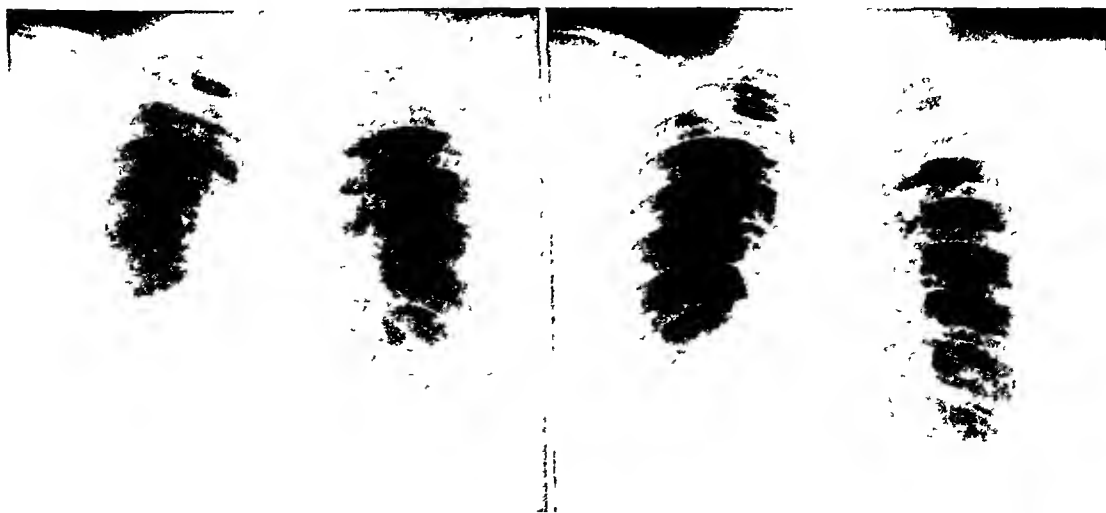


Fig 4 Roentgenogram taken October 28, 1931, shows rounded mass in lower left lung, characteristic of a metastatic growth. One year previously the right leg was amputated for sarcoma of the lower femur. Following irradiation therapy to the pulmonary lesion there was

complete regression. The roentgenogram taken April 9, 1936, shows no evidence of metastatic lesions and the patient is at present well and clinically free from active disease 7 years later.

TABLE I—RESULTS OF IRRADIATION THERAPY ON 13 PATIENTS WITH PULMONARY METASTASIS

Patient Age & sex Hospital No.	Primary lesion	Roentgen graph of chest	X-ray therapy calculated effect vs tumor dose	Immediate results (Roentgenograph appearance)	Subsequent clinical course
1 GF 42 <sup>♀</sup> 100534	Embryonal carcinoma of testis	Large rounded masses in both lungs	4500 r in 307 days total to both lungs	Complete regression of masses in both lungs	Died 4 mos later of generalized metastatic tumor nodules in lungs at necropsy
2 RA 25 <sup>♂</sup> 170607	Embryonal carcinoma of testis	Large nodular masses in upper lobes of both lungs	4000 r in 18 days total to both upper lobes	Complete regression of masses in both lungs	Subsequently died prior to survival is known
3 WK 42 <sup>♂</sup>	Embryonal carcinoma of testis	Large rounded masses in upper mediastinum	4000 r in 36 d 34	Complete regression of masses	Died 15 mos later of metastatic tumor of mediastinal tumor
4 LC 5 <sup>♂</sup> 701	Carcinoma of kidney	Large rounded masses in upper right lung	3500 r in 90 days	Complete regression of masses	Death of generalized metastatic 5 mos later
5 ML 31 <sup>♀</sup> 974	Carcinoma of breast	Moderate sized masses in both lungs	3500 r in 4 mos	Partial regression of masses	Died 1 yr later of carcinoma
6 HA 31 <sup>♀</sup> 97454	Carcinoma of breast	Multiple rounded masses in both lungs	3000 r to each lung in 5 mos	Marked regression of metastatic masses	Died 1 yr later of carcinoma
7 CN 50 <sup>♀</sup> 20706	Carcinoma of breast	Multiple rounded masses in both lungs	1050 r in 6 mos to each lobe	Marked regression of metastatic masses	Alive 12 mos later—clinical improvement
8 GP 44 <sup>♂</sup> 104715	Hypernephroma of kidney	Round masses in lower portion of left lung	2600 r in 2 days	Marked regression of metastatic masses	Clinically much improved 12 mos later
9 JFP 41 <sup>♂</sup> 15455	Round cell sarcoma (fasciitis) of thigh	Multiple rounded masses in both lungs	4000 r in 10 days	Complete regression of masses	Recurrent metastatic masses in both lungs and sarcomatous died 4 mos later
10 HC 19 <sup>♂</sup> 8353	Ewing's carcinoma of pelvis (primary lesion treated by X-ray)	Single rounded mass in lower portion of left lung	2000 r in 7 days	Complete regression of mass	Clinically free from active disease 12 mos later
11 SE 21 <sup>♂</sup> 10123	Ewing's carcinoma of pelvis (primary lesion treated by X-ray)	Large mass in mid portion of right lung	1200 r in 9 days	Complete regression of mass	Clinically free from active disease 12 mos later
12 MB 46 <sup>♀</sup> 27350	Fibrosarcoma of lower limb (amputation)	Single rounded mass in mid portion of left lung	800 r in 4 mos	Complete regression of mass	Well 1 yr later
13 CF 60 <sup>♂</sup> 100707	Carcinoma of right breast	Multiple rounded masses in both lungs	1500 r in 60 days	Complete regression of masses	Eventually died of carcinoma

## ADDENDUM TO TABLE

CA 83. Patient developed recurrent metastatic disease in the transverse colon which was irradiated field of right retroperitoneal metastatic mass treated at same time as mediastinal lesion (see report by Brunschwig and Fox).

CA 85. Patient developed bronchogenic carcinoma complicating metastatic disease in right lung. This irradiated end patient lived several months after the last irradiation. She also had skeletal metastases.

CASE 9. Patient received X-ray therapy to treat for intrathoracic metastases producing severe symptoms. After 10 mos and 2 also X-ray therapy to liver hepatic mass. While receiving therapy to lungs. During period of palliation the patient died almost a year after the last irradiation.

CASE 7. Extensive skeletal metastases causing severe pain also irradiated with X-ray. It is difficult to judge the effect of the X-ray therapy on the metastatic masses. This fact does not in itself indicate that the lesions observed were something other than metastatic growth since pulmonary metastases have been observed to appear stationary for long periods. The nature of a check-up has been verified (necropsy). (See report by Fox).

ment in any series of patients. This would hardly be possible in view of the very marked variation in the clinical picture presented by each case such as the general condition, site and number of metastases elsewhere than in the lungs, type of neoplasm, age, etc. While this series of patients is not an especially selected one it does not include an equal number of patients with extensive pulmonary and other metastases who were also treated but with no appreciable results.

The purpose of this report is to demonstrate that immediate marked or apparent complete regression of pulmonary metastases in roentgeno-

grams of the chest may not infrequently follow irradiation therapy and that this is occurred in the above series is accompanied by a varying degree of palliation of local and general symptoms for a brief or a more prolonged period. The argument that such treatment may entail eventual tissue damage and augment the general depression resulting from anemia etc. would not appear to be a serious contra-indication to such treatment since small to moderate doses have in this series proved effective and measures may be adopted to combat anemia which such doses might induce.

It is not intended to carry the impression that irradiation therapy of pulmonary metastases offers a means to alter noticeably the course of the advanced stage of malignancy as found in large numbers of patients. It is believed, however, that such a procedure, when followed judiciously, offers a possibility of palliation in certain individual cases, especially when the general condition of the patient is not bad at the time such metastases are first observed.

#### CONCLUSION

Moderate irradiation of pulmonary metastases from malignant tumors is indicated as an attempt at palliation in cases in which evidence of such

metastases is first discovered, and in cases in which the general condition of the patient is at least fair.

#### BIBLIOGRAPHY

- 1 BRUNDSCHWIG, A, and FOX, F Correlation of roentgen ray dosage and necropsy findings, etc. *Ann Surg*, 1937, 105 265
- 2 FUSSL, E Der metastatisch lungen Karzinose Roentgenpraxis *Strahlentherapie*, 1937, 9 184
- 3 HOHLFELDER, H H Tiefentherapie Leipzig Georg Thieme, 1938
- 4 SCHULTE, G Erfolge bei Knochentumoren *Strahlentherapie*, 1936, 57 370
- 5 TREVES, N Is roentgen irradiation of value in the treatment of pulmonary metastasis from mammary cancer? *Am J Roentgenol*, 1938, 39 783

# THE SURGICAL TREATMENT OF CARCINOMA OF THE LARYNX

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**S**URGICAL intervention has proved to be the most efficient method of treating patients with carcinoma of the larynx. The surgeon, however, in order to give all patients with this disease the best that can be offered and taking into consideration those who are poor surgical risks and inoperable cases must be able to employ not only pure, surgical procedures but, in addition surgical diathermy, radon seeds inserted under suspension laryngoscopy, and external irradiation.

## DIAGNOSIS

Growths in the supraglottic region may produce few, if any, symptoms until they are large, so that growths of the epiglottis are frequently overlooked. The patient may have an undetermined pain or ache in the throat with little difficulty in swallowing, and the growth particularly if it be situated on the posterior surface of the epiglottis may evade inspection unless a careful examination is made. Until these growths have extended into the larynx hoarseness is not produced.

Growths of the glottis cause hoarseness as an early symptom so that adult patients who are hoarse over a period of a month should have a careful examination to make sure that the hoarseness is not due to a malignant lesion. It is generally thought that malignant tumors of the larynx usually occur in men. While this is true one sees many malignant tumors of the larynx in women in whom a thyrotomy and, in some cases, a laryngectomy is necessary.

Age should not be a factor in deciding the likelihood of a malignant tumor as the ages of the patients at The Mayo Clinic on whom it has been necessary to perform laryngectomy ranged from 16 to 77 years. In the uncertain case preliminary biopsy is always advisable, the patient and his relatives understanding the surgical procedure that should follow the positive histological diagnosis. I do not think it advisable to perform a biopsy in a possibly malignant laryngeal lesion unless treatment is to follow immediately.

From the Section on Laryngology, Oral and Plastic Surgery, The Mayo Clinic.  
Presented in the Symposium on Cancer before the Clinical Congress of the American College of Surgeons, New York, October 17-21, 1933.

After excluding the usual conditions considered in differential diagnosis of malignant tumor of the larynx, that is tuberculosis, syphilis, benign tumors and granulomas of contact ulcers and some of the more unusual lesions, there remains a group of patients with pathological conditions of the larynx in which it is impossible to make a definite clinical diagnosis. In this group of patients exposing the larynx by means of suspension laryngoscopy is a valuable aid, not only in the diagnosis but also in the treatment of many of these laryngeal lesions. Many larynges, presenting thickening caused by inflammation, thickened leucoplastic areas of epithelial hyperplasia and other so called precancerous lesions are better visualized by binocular examination as obtained under suspension laryngoscopy. This type of laryngoscopy is used with intratracheal gas and ether anesthesia and allows of an excellent exposure of the larynx. In this way an accurate biopsy may be obtained.

In cases in which histological examination of the fresh frozen section proves the condition to be a benign one such as leucoplastic epithelial hyperplasia caused by inflammation or a very small early epithelioma the lesion may be destroyed under suspension laryngoscopy with a long protected surgical diathermy point. Before diathermy is used the etherization of the patient is discontinued and he is allowed to take several deep breaths. The anesthesia is then continued with nitrous oxide only. In those cases in which benign lesions and early epitheliomas are removed endoscopically by surgical diathermy, careful surgical judgment must be used in selection of patients. In elderly patients and patients that are bad surgical risks the results show that this method of removal can be used with much less danger and with a good prognosis in selected cases. In the cases in which the lesion is more extensive suspension laryngoscopy allows of a thorough examination and a decision may be made at the time as to whether a thyrotomy and exploration or a laryngectomy should be done.

## METHODS OF SURGICAL REMOVAL

Surgical procedures including removal and surgical diathermy are the most effective methods

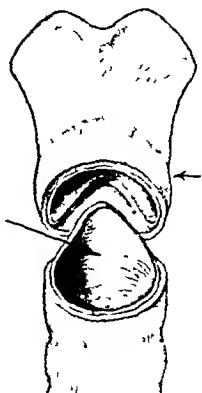


Fig 1 The mucous membrane flap, indicated by long arrow, that is dissected from the posterior wall of the cricoid cartilage, indicated by short arrow, in cases in which the situation of the growth will permit

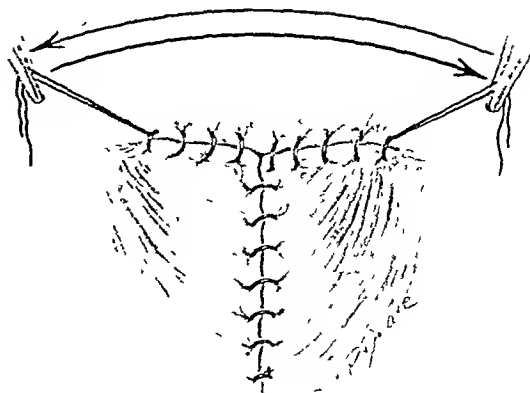


Fig 2 Closure of the pharynx with two rows of chromic catgut sutures in the shape of a T

of treating carcinoma of the larynx. In addition to these, however, the use of radon seeds and external irradiation is of great value in many cases. It is the evaluation of the various methods of treatment and their application to the individual case that makes the most efficient method of treatment for malignant tumor in its various locations and types. In determining the best method of treatment, the duration of the history of hoarseness, the location of the lesion and its extent, the histological grade of the tumor, the question of metastasis, the patient's age and general condition as to surgical risk, must all be considered. These are all questions which play an important part in the surgeon's decision.

Carcinoma of the larynx may be divided into 3 groups: (1) the supraglottic growths, (2) the intralaryngeal growths, including the subglottic, and (3) laryngopharyngeal growths arising in the pyriform sinus or the postcricoid region. Many of these growths may involve one or possibly more of the regions but the smaller growths will come under this grouping. The type of carcinoma present may be determined by the appearance of the tumor and the microscopic grading. Unless the type of growth is such that it can be cared for in a conservative way and the excision made well wide of the growth, a more extensive operative procedure should be employed. The work of New and Fletcher on the selection of treatment for carcinoma of the larynx brought out the fact that the low-grade tumor could be removed with a much narrower margin than the more active growths.

The patient's age and general condition are very important factors in determining the treatment. Patients more than 75 years of age or those with poor general conditions, such as bronchiectasis, diabetes, or angina, are subject to added surgical risks and while they may withstand a major surgical procedure, a less radical one is advisable sometimes under the circumstances. It is in these elderly patients that a two stage operation, of which the first is a preliminary tracheotomy, is of great value. In some of these, too, the use of suspension laryngoscopy and removal of the growth perorally is advisable, and in some external irradiation only is employed. In many cases it is necessary to do a thyrotomy as an exploratory operation before the particular surgical procedure to be employed can be decided on. While conservation of the voice must be considered whenever possible, the eradication of the disease is of the first importance.

*Supraglottic growths* Tumors of the epiglottis are usually of a low grade of malignancy. However, tumors of the base of the tongue of a high grade of malignancy may involve the epiglottis. In growths in which the lesion is limited to the epiglottis, removal with surgical diathermy under suspension laryngoscopy gives excellent results. Even in cases in which the growth involves the base of the tongue, it may be thoroughly removed with diathermy and radon seeds can be inserted into the involved area. To illustrate how extensive destruction may be accomplished by this method, in 1 case I removed the inner surface of the hyoid bone as a sequestrum. The patient, who had an extensive squamous-cell epithelioma,

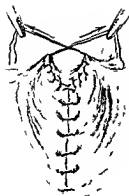


Fig 3 Tying of the sutures at the extremities of the horizontal portion of the T in this way burying the upper portion of the wound

grade 4 on a basis of 1 to 4, was well at the time of this writing which is more than 5 years after operation

In the supraglottic tumors in which the aryepiglottic fold is involved, pharyngotomy through the thyrohyoid membrane or lateral pharyngotomy is the treatment of choice. In this way a wide exposure can be made and as radical an excision performed as is necessary. At times a window may be removed from the thyroid cartilage on the opposite side to the growth, or the thyroid cartilage divided allowing an excellent exposure through which the growth may be destroyed with surgical diathermy. A transmandibular and translingual exposure as used by Trotter to remove epiglottic growths, is technically an excellent operative procedure, but I feel that other methods are far more efficient and that they result in a much lower operative mortality.

Carcinoma of the epiglottis may fill almost the entire hypopharynx so that only a margin of the larynx is visible. There is a tendency for these low grade tumors to be more of an excrescence like a cauliflower that has gone to seed, than an invading growth. If the growth is an infiltrating one without limited margins, removal under suspension laryngoscopy should not be attempted. In some supraglottic growths which involve the aryepiglottic fold and the pyriform sinus, laryngectomy along with removal of a portion of the lateral wall of the pharynx is feasible. The type of operation and the technical procedure which are to be employed should be suited to the individual lesion.

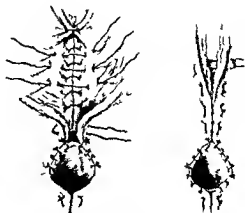


Fig 4 Left the pharynx is closed with a second row of chromic catgut sutures. Skin sutures approximate the skin and tongue-shaped flap. A mattress suture which is carried through the anterior wall of the esophagus, closes the skin above the trachea. Right, mattress sutures complete the closure of the skin above the trachea. The lateral Penrose cigarette drains and the iodoform gauze pack in the upper portion of the wound are not shown.

**Introlaryngeal growths.** Malignant lesions involving the inside of the larynx may be taken care of in several ways. Thyrotomy and exploration are advisable in many cases in which the exact limits of the lesion are undetermined and in which there is a question as to whether a conservative operation or a laryngectomy is advisable. Surgical diathermy is used in all cases in which thyrotomy is employed. The early lesion without fixation is widely removed and the base destroyed with diathermy. When the lesion is more advanced with possibly some limitation of movement involving the anterior two-thirds of the vocal cord, the growth is removed along with the cartilage and the base is destroyed with diathermy. This is really a hemilaryngectomy. In growths involving one vocal cord and the anterior commissure without fixation, or in which the anterior commissure is involved along with the anterior half of both vocal cords, the method suggested by Jackson for low grade tumors gives excellent results. One must remember however that frequently growths involving the anterior commissure may extend through the cricothyroid membrane, and also that in highly malignant growths one cannot get a wide enough margin unless the anterior portion of the thyroid cartilage is removed as well as the soft tissues. If a wide removal is made in this manner the patient may still have an airway and a passable voice. Larynx

gectomy is done in more extensive lesions in which, owing to the size, location, and type of the growth, a conservative removal, which allows of a sufficient margin of safety, cannot be performed.

When laryngectomy is done, I use paravertebral anesthesia and I prefer the midline incision. I then divide the hyoid bone and retract it laterally with rake retractors. The larynx is freed from the muscles, first on one side and then on the other. On account of the possible extension of the growth through the thyroid cartilage or the cricothyroid membrane, it is essential that this dissection be made very carefully. If there is any question of extrinsic involvement at this point, wide excision, either with a knife or with surgical diathermy, is advisable. The trachea is cut across below the growth and procaine is then injected into the posterior wall of the larynx and trachea. If the extent of the growth will permit, a tongue-like flap of mucous membrane and submucous tissue is dissected free from the posterior wall of the cricoid cartilage, leaving it attached to the tracheal mucous membrane (Fig 1). This aids in the closure of the skin to the trachea. It is necessary to inject some procaine into the pharynx after the trachea has been cut across, since it is difficult to block this area with paravertebral anesthesia.

Dissection is then carried up onto the posterior wall of the larynx. The pharynx is opened, and in cases in which there is some question as to the posterior extension of the growth, exploration is made with the finger at this time. The larynx is then removed. The opening into the pharynx in the shape of a T is closed with two layers of fine, chromic catgut sutures (Fig 2). The sutures at the extremity of the crosspiece of the T are left long and after the rest of the pharynx is closed are tied together, thus burying the central portion of the wound (Fig 3). The trachea is sutured to the skin by means of silk sutures. One mattress suture just above the trachea is carried through the anterior wall of the esophagus in order to bring it forward against the skin. Mattress sutures are used in closing the lower 5 centimeters of the skin above the trachea. Rubber Penrose cigarette drains are carried into the pockets on either side and an iodoform gauze pack is placed in the upper part of the wound. A No. 7 tracheal tube is inserted and a dressing is applied over the upper part of the neck (Fig 4).

Little reaction follows operation by the procedure I have outlined if a preliminary tracheotomy has been made. The temperature usually does not go above 100 or 101 degrees F and after about 4 days goes back to normal. The drains

are removed gradually; they are usually out about the tenth day. In a large percentage of cases, the closure about the posterior wall of the trachea and lower 5 centimeters of the incision heals almost by primary intention. If, as frequently happens, a small pharyngeal fistula is left at the upper end of the incision, it is freshened up after the wound heals sufficiently and is closed with mattress sutures. The tracheal tube is usually removed about the fourth day and kept out the greater part of the time unless there is some tendency for the tracheal opening to close. In this way less reaction occurs about the upper end of the trachea. In regard to the question of removal of lymph nodes in these cases, I do not do a routine block dissection of the necks of patients who have a malignant lesion of the larynx without involvement of the nodes. In cases in which there is nodal involvement of low grade, I feel that the lymph nodes should be removed. To illustrate the value of neck dissection, 1 patient with squamous-cell epithelioma, grade 2 of the cervical lymph nodes, lived for 18 years after operation and died of adenocarcinoma of the stomach.

*Laryngopharyngeal growths.* Postcricoid growths are practically always squamous-cell epithelioma, grade 4, but may be of low grade and, as a rule, are found in women. A lymph node is usually palpable at the time of the first examination. Trotter's method of doing a transthyroid pharyngotomy is the treatment of choice if there is no involvement of the lymph nodes and the patient is otherwise a good surgical risk. However, the prognosis in these highly malignant tumors in this region is such that, unless the operation is done early, surgical intervention offers little except in a limited group of cases. Tumors of the pyriform sinus are usually squamous-cell epithelioma, grade 3 or 4, and usually metastasize early.

It is in these two groups of cases, involving the postcricoid region and the pyriform sinus, that external irradiation has accomplished a great deal and in my opinion it should be the treatment of choice. I have had 2 such patients that have been greatly benefited by irradiation.

One was a man, 45 years of age, with the growth involving the arytenoid and postcricoid regions, a squamous-cell epithelioma, grade 3, causing laryngeal obstruction. I performed a tracheotomy and then followed this with roentgen therapy in small fractional doses. The tumor disappeared entirely and the patient has been well with no recurrence 18 months later. The second patient was a man, aged 55 years, with a growth in the pyriform sinus, grade 2, with 2 midcervical lymph nodes that felt malignant. After roentgen therapy the enlargement of the nodes disappeared as well as the local lesion and the patient has been well nearly 2 years.



Neither of these patients would have been benefited by surgical intervention whereas roentgen therapy has obtained an apparent cure. These, however, are only 2 of the many patients who have been treated but they do tend to show that in certain cases the use of irradiation is well worth while.

Quick stated that the present status of irradiation therapy renders total laryngectomy obsolete, that an early malignant tumor is as favorable for irradiation as for surgical extirpation and that the ultimate results are better. He did not, however, present sufficient evidence to back up such sweeping statements. The end results in surgical treatment of malignant lesions of the larynx are well known. The operative mortality rate is less than 3 per cent and the end results show that

between 50 and 60 per cent of patients requiring laryngectomy are alive 5 years later. Good speech may be obtained in most patients on whom thyrotomy has been performed by the good vocal cord approximating a scarred band. In patients for whom laryngectomy has been necessary the use of the pharyngeal muscles or an artificial larynx frequently produces much better speech than the pre-operative voice.

The selection of treatment in carcinoma of the larynx requires keen surgical judgment. The laryngologist, who wishes to give efficient treatment to all patients, must use, as they seem indicated, all of the various methods that the medical profession has at its disposal. The problem is to evaluate and apply them efficiently to each individual patient.

# X-RAY TREATMENT OF INOPERABLE CARCINOMA OF THE LARYNX

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**C**LINICALLY and histologically there exist 2 main varieties of laryngeal cancer: cancer composed of undifferentiated cells, and cancer composed of differentiated cells. The former live in a loose vasculo-connective tissue which is itself undifferentiated and disorganized. In this tumor bed the neoplastic cells multiply rapidly, at the same time respecting the highly differentiated tissues such as nerves, blood vessels, and muscles. They are in contact by the lymphatic spaces with the lymphatic vessels, and they have a tendency to early and widespread dissemination in the loose vasculoconnective tissue. They are accompanied by early regional adenopathy whose evolution is irregular, sometimes rapid and sometimes stationary, or even regressive when they originate from the vestibule or the ventricular cavity. This type of cancer generally arises in regions which for many years have been the site of acute inflammatory changes, the inflammatory processes having induced certain modifications.

The differentiated variety of cancer cells lives in a dense and highly organized vasculoconnective tissue bed, and sometimes in the muscle itself, for which it has a special affinity. At first these cells infiltrate the intermuscular spaces, afterward penetrating the muscle fibers and causing an early immobilization of the underlying muscle. In regions where they grow the lymphatics and blood vessels are destroyed, the nerves are compressed and the nerve sheaths are infiltrated. Cancers with differentiated cells have no tendency to distant dissemination. They develop slowly and penetrate the lymphatic and vascular tissue later. They are generally of limited extent and of small size. Regional adenopathy is rare. When it occurs, its development is irregular and slowly progressive. These cells appear in a region in which a chronic inflammatory state has led to a special modification in the dense connective tissue.

## CHOICE OF TREATMENT

These facts explain why the undifferentiated cancers composed of cells which are young, wan-

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dering, and highly fragile in the presence of external agents, disappear promptly under the influence of radiation regardless of their size, whereas, cancers composed of differentiated cells, which exhibit more mature evolution without great movability and remain close to their source of origin, behave differently.

The tendency of differentiated cells to live together in a group and to be intimately associated with muscle distinguishes them from undifferentiated cells which conserve their complete independence in relation to the tumor bed in which they live. Muscle infiltration is a peculiar and characteristic feature of differentiated cells which results not only in the muscle becoming rapidly immobilized but also in an intimate association of the neoplastic cells and muscle fibers which it is impossible to separate. In this process the neoplastic cells appear to receive their nourishment from the muscle fibers which slowly lose their biological properties, leading to a replacement of the muscle fibers by fibrosclerotic tissue. Under these circumstances the disappearance of differentiated neoplastic cells under the influence of radiation is almost impossible.

If one succeeds in sterilizing a lesion of this type by means of x-rays, a result which is very rare, there always develops a necrotic destruction of the treated area either immediately or after 3 months, 6 months, or 1 year. Examples of this type of lesion are highly differentiated and infiltrating cancers of the vocal cord, differentiated cancers of the anterosuperior part of the tongue, and cancers of the anterior part of the pillar, which are composed of differentiated cells. Sterilization of the tumor with conservation of the tissues of the tumor bed under these conditions is not possible. The union of the neoplastic cells and surrounding normal cells has been too intimate. Necrosis of the anterosuperior portion of the tongue following sterilization of the epithelioma is of no great significance, but necrosis of the tissues occupied by the neoplasm at the level of the larynx, even with complete disappearance of the cancer, always results in death if there has not been a previous tracheotomy, and sometimes provokes bronchopneumonia even with a previous tracheotomy. The elimination of the necrotic

portion, which may be soft or cartilaginous, requires too great an effort on the part of the tissues and organism and is sometimes prolonged for as much as 2 years before elimination and repair are complete. The treatment of differentiated cancer of the larynx which infiltrates and immobilizes the underlying muscle belongs, therefore, to the domain of surgery rather than to that of radiology.

In summary, differentiated cancers of the larynx which are technically operable belong to the domain of surgery if the hemilarynx is completely fixed. It is only when the immobilization is incomplete that this type of cancer can be cured by irradiation.

Cancers composed of undifferentiated cells are easily modified by radiation regardless of whether they are small or large, operable or inoperable. This variety of cancer is best treated by radiation. In this type, regardless of the degree of development the invaded parts remain slightly movable and the lesion disappears without apparent modification of the connective tissue in which it has developed. Because of their tendency to cellular dissemination, the undifferentiated cancers are never biologically operable even though they are technically operable. Surgical intervention increases the danger of dissemination. We might emphasize the danger of surgical intervention in this type even when the surgical procedure is adequate by demonstrating a large number of cancers of the larynx, pharynx, oral cavity, and breast, but we think that these facts are already so well known that this is not necessary.

#### METHOD OF ROENTGEN THERAPY

Following are the methods of x ray treatment in brief, for it is a subject which is only of limited interest.

*Cellulicidal technique—radio epithelitis, radio epidermite.* The treatments which have been used until now have had for their aim the destruction of neoplastic cells, that is to say a cellulicidal technique. After some days of treatment, the cells are covered by a false membrane when the cancer is composed of undifferentiated cells. Depending upon the degree of differentiation, these false membranes appear between the fifth and thirteenth days after the beginning of treatment. On the thirteenth day the false membrane appears on the normal mucous membranes (radio epithelitis). When a cancer is composed of cells which are more fragile than those of the normal epithelium of the mucous membrane the false neoplastic membrane appears before the false membrane of the normal mucous membrane. If the neoplastic cells do not show a false membrane

until the sixteenth or seventeenth day or later, it is because they are less sensitive than the normal cells of the mucous membrane. Under these conditions we are dealing with a cancer whose cells are more differentiated. If no cellular modification or diminution in size appears before the twenty fifth day, it is because the sensitivity of the cells is in the neighborhood of those of the cutaneous cells which are destroyed only between the twenty sixth and twenty eighth days (radio epidermite).

This information is valuable for cancers which are not infiltrating, that is to say, those which have respected the muscle. As soon as the cells have invaded the muscle, the cellulicidal method is, as we have already said, not effective because it is unable to yield any rational cure that is sterilization of the cancer with conservation of the normal tissues. Consequently, we shall discuss here only the cellulicidal technique as it is applied to undifferentiated or slightly differentiated cancers which have not infiltrated the underlying muscle. This technique may be applied in several ways.

*Daily and continuous treatment.* The roentgen therapy of cancer of the larynx gives us results only when we distribute in the larynx through two lateral fields 50 centimeters square, a total dose of 7,000 r that is, about 5,000 r to the side of the lesion and 2,000 r to the opposite side measured on the skin. This daily continuous treatment is distributed as follows: in 20 to 25 days for cancers composed of slightly differentiated cells, in 15 days at a maximum for cancers composed of very differentiated cells and in 40 days for cancers which are completely undifferentiated. There is a tendency now to reduce this time.

*Preparatory treatment.* If the cancer is very extensive and very infected and the general state of the patient is bad, we precede the main treatment by a preparation lasting for 13 to 26 days, without interruption between the two varieties of treatment. The fields are increased on the surface reaching 100 square centimeters and administered between 5 and 50 r according to the voltages and according to the thickness of the tissues. The aim of these irradiations is not to act on the neoplastic cells whose cellulicidal threshold never appears below a daily dose of 150 r, but to reduce the infection and to improve the connective vascular tissue. It is, therefore, necessary to diminish as much as possible the daily dose in order to avoid the development by the rays of fibrosclerotic connective tissue, a transformation which reduces the sensitivity of

the cells. This method was used for all the cancers of the larynx in 1932 and seems to us to be the cause of improvement in 5 year results.

*Periodic treatment* We have also studied the effects of periodic treatment in the differentiated forms of cancer. Non-continuous treatment in 2 or 3 periods, distributed in such a manner that the moment of cellucidal effect coincides with the moment of sensitivity of the normal epithelium of the mucous membrane, which appears on the thirteenth, twenty-sixth or thirty-ninth days. This coincidence is possible only if the daily dose largely surpasses the cellucidal threshold of the differentiated neoplastic cells, which is rarely less than 400 r. This treatment constitutes the only method which has given us any results for cancer of differentiated cells.

*Palliative treatment* In cases not successfully treated by radiation, as for example in the case of a recurrence, and in cases in which it is impossible to administer efficacious treatment by radiation on account of marked cachexia, all varieties of treatment known as palliative treatment simulate the type of treatment which has been described as *preparatory*, but with still weaker daily doses, or 5 to 25 r, and with an aim only to modify favorably the vasculoconnective tissue.

#### ASSOCIATION OF SURGERY AND ROENTGEN THERAPY

The combination of surgery and x-rays in the treatment of inoperable cancer of the larynx has not yielded any better results than those obtained by surgery alone or by x-rays alone. In the treatment of postoperative recurrence, non-sterilization after x-ray therapy is often associated with necrosis at the site of the operative scar. This necrosis has sometimes resulted in a large fistulous tract extending from the larynx into the skin. On the other hand, when a surgical operation is performed upon a recurrence following irradiation, radionecrosis of the soft parts and cartilage is frequently produced.

These complications are due largely to the fact that the combination of irradiation and surgery is utilized as a result of urgent necessity rather than a careful and deliberate study of the problem before treatment is instituted.

Let us consider two groups of cases in which the association of these two therapeutic agents is carefully studied before treatment is begun.

1 In the management of differentiated carcinomas which infiltrate the muscle and which are inoperable without being too extensive, it is sometimes useful, after tracheotomy, to perform an intentionally incomplete operation in order to

conserve the greater part of the larynx. This operation, the aim of which is to remove the most radioresistant portions of the lesion, is followed as soon as possible by complete irradiation. This irradiation should be administered before there has been a chance for fibrosclerosis to develop. During the time immediately after operation, there exists a type of postoperative cellular activity which renders the tumor cells more radiosensitive. When this type of cancer, which is composed of differentiated cells, has destroyed the muscle and cartilage, the operation serves to eliminate the infected and necrotic tissues.

2 In the management of carcinomas composed of undifferentiated cells the following procedure is adopted. If one chooses to treat this form of cancer surgically, it is wise to precede the operation by comparatively small doses of x-rays, that is to say, 3000 r units administered in 10 to 12 days. A daily dose of 250 to 300 r units will suffice to cause the disappearance of the most fragile cells which are the most dangerous elements from the point of view of postoperative dissemination. The surgical operation should follow the irradiation by about 17 days at the latest after the first x-ray treatment.

For the reasons which have been discussed, it is necessary that the therapeutic procedures in both circumstances be grouped as closely as possible in order that the second treatment receive the greatest benefit from the first.

#### RESULTS

*General results.* As to patients treated in our service in the Curie Foundation in 1921 to 1932 for inoperable cancer of the larynx or for postoperative recurrence, out of a period of 12 years of treatment, 3 years only yielded good results. They are 1921, 1926, and 1932, with 50, 52, and 66 per cent 5 year survivals and free of disease. The other years are bad or mediocre. The general average for 5 year survivals is only 39 of 142 patients or 27 per cent. The study of all these cases has established that cancers composed of undifferentiated cells were very numerous in the 3 favorable years, and that cancers composed of differentiated cells were very numerous in the course of the bad years. This accounts in part for the inequality of the results, but in fact our inadequate knowledge of the effects of radiation on cancer, very dissimilar from the point of view of cellular differentiation, muscle invasion, invasion of cartilage, and musculocartilaginous necrosis, explains that our technique was sometimes efficacious and sometimes not. In an effort to correct the dissimilarity in results, we have

been obliged to test every kind of treatment. These changes in technique have sometimes appeared contradictory.

The factors just mentioned partly explain the results during a course of successive years. The best year, 1921, was followed by the worst year, 1922, since in the latter we did not have a single 5 year cure out of 11 patients treated.

Likewise, after 1926 we had a series of mediocre years: 14 and 16 per cent in 1929 and 1930, respectively, are the worst results after 1926. In 1931 there were 28 per cent. The results attain their maximum in 1932 after which the percentage will probably go down again.

During the course of these 12 years, the duration of treatment was sometimes long and sometimes short. The treatment periods have varied from 10 to 50 days: the daily dose between 200 r and 800 r measured on the skin; the fields between 40 and 150 centimeters square. In spite of these variations the total dose which caused the disappearance of cancer of the larynx remained in the neighborhood of 7000 r.

#### CRITICAL PERIOD AFTER FIVE YEAR SURVIVALS

Among the 8 patients treated in 1921, 4 reached the 5 year survival period without signs of cancer; they are still free of disease after 10 and 15 years.

The patients treated in 1926 and 1932 reached a 5 year survival in a higher proportion: that is 9 out of 17 or 52 per cent, and 6 out of 9 or 66 per cent, but the results after 5 years are inferior to those of 1921.

Among the 17 patients treated in 1926, of which 9 reached the 5 year period with freedom from symptoms, 4 subsequently died: 3 died of new cancerous manifestations of the larynx: 1 during the course of the sixth year and 2 during the course of the eighth year. The fourth patient died at the advanced age of 79 years during the course of the ninth year without apparent recurrence. Thus there are 3 deaths with new cancerous manifestations between the sixth and the eighth years, that is, 3 out of 9, or 33 per cent of the patients who survived 5 years. These manifestations appeared in the 3 cases at the end of the sixth year. The number of patients surviving without symptoms remains the same, 9 at 12 years after treatment.

Among the 9 patients treated in 1932, 6 have reached the 5 year period without symptoms. Of these 6, 2 have died during the course of the sixth year of new cancerous manifestations: 1 case was a postoperative recurrence.

In summary, of 15 patients remaining free of disease for 5 years: 5 or 33 per cent have developed

a new cancerous manifestation during the sixth year. Thus it seems that about the end of the sixth year, there appear special phenomena which are able to provoke the appearance of new cancerous manifestations.

Certainly the number of cases of cancer of the larynx observed is not large. We should not be permitted to speak of these facts if we had not seen similar phenomena in other locations. In our cases of cancer of the oral cavity and of the tonsil in particular, when a patient presented a new cancerous manifestation death occurred between the sixth and eighth years. The new cancerous manifestations seem to begin about the end of the sixth year, and the patients who escape this manifestation remain without symptoms for 10 to 15 years.

In the treatment of undifferentiated carcinomas which are apparently cured, there seems to exist a critical period appearing about 6 years after the irradiation. This critical period causes death 1, 2, or 3 years later and if the patient escapes this critical period the cure appears to be definite.

The question arises as to whether this period is the same in other types of tumors. We are completely ignorant of this. Although we have observed this in adenocarcinoma of the breast composed of undifferentiated cells, still in general the number of these cases of 5 year survivals is too small. The statistics of the Registry of Bone Sarcoma of the American College of Surgeons shows that of 112 cases of bone sarcoma living and clinically free of disease for a period of 5 years or more following treatment by surgery or by irradiation: 6 patients died of cancer after 5 years, of which 3 died of metastasis during the course of the eighth year.

#### ONE OF THE CAUSES OF THE APPEARANCE OF THE CRITICAL PERIOD

The changes in the methods of treatment which we have considered in their time as improvements did not always constitute real improvements or more precisely we now see the advantages and disadvantages of the different methods utilized.

This is especially true of the methods applied in 1926 and 1932, which have given us results that seem superior to those of 1921. This improvement in results was apparent and not real. Certainly the percentage of 5 year survivals without symptoms has increased but this increase, as we have said, is compensated by the lowering of the duration of the survivals, since the results of 1926 and 1932 fall during the course of the critical period from 52 and 66 per cent to 33 and 44 per cent.

The disappearance of all the neoplastic cells in the cases of 5 year survivals has been obtained regardless of whether the treatments were long or short. However, when the daily doses have not reached a certain minimum threshold, particularly during the course of the last days of irradiation, the critical period has appeared; and this would suggest that after the disappearance of the neoplastic cells, special elements remained which were not modified by the treatment. We find the same effect in other locations

What are these special elements? Are they cellular? Are they composed of a special group of invisible mother cells, hidden in a sclerotic vasculoconnective tissue such as one sees in cancer of the breast in which new cancerous manifestations seem to appear at every period after 5 years? This is only remotely probable since the moment of the cancerous manifestations seems fixed, 6 years

On the contrary, are they formed of a substance having cellulomitic properties or a carcinogenic substance whose cancerization effect appears after 6 years? We should be obliged to admit it if the moment of the critical period were the same for all varieties of cancer.

Regardless of the theoretical considerations which these facts suggest, they bring to us for the moment useful indications for radiation technique which may permit us to escape the critical period and avoid recurrence. These facts teach us especially that for the same total dose we must reach a high threshold during the course of the final daily treatments, a threshold sometimes greater than 800 r. On the contrary, under certain conditions, daily doses of 5 r preceding the cellulocidal treatment appear efficacious by a process of which we are totally ignorant. This possibility of utilizing extreme variations in the

daily doses and in their effects in roentgen therapy is a fact not only very curious but encouraging for the future.

#### SUMMARY

Clinically and histologically there exist two main varieties of laryngeal cancer: cancers composed of undifferentiated cells having a great tendency to early and widespread dissemination in the loose vasculoconnective tissue, and cancer composed of differentiated cells having a special affinity for the muscles and an immobilization of muscle without any tendency to dissemination.

Cancers composed of undifferentiated cells are treated successfully and easily by x-rays. Because of their tendency to dissemination, they are not biologically operable, even though they are technically operable.

Cancers composed of differentiated cells are in the domain of surgery, and usually are not curable by radiation because of the intimate connection between muscle cells and carcinoma cells.

Treatment of inoperable cancers by x-rays which we have used are: (1) preparatory treatment, (2) daily and continuous treatment, and (3) periodic treatment.

The preparatory treatment has increased the number of 5 year survivals, but the insufficient daily doses during the last 3 days of treatment has provoked sometimes the appearance of a recurrence about 6 years after irradiation. This seems to be the critical period, and death occurs 1, 2 or 3 years later. If the patients escape this critical period, they are still free of disease after 15 years. The possibility of utilizing extreme variations in the daily doses, very small or 5 r in the preparatory treatment, and very high, or 900 r during the last day of the continuous treatment, is very encouraging for the future.

# OBSTETRICS AND GYNECOLOGY

## ESTROGENIC HORMONES AND CARCINOGENESIS

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AS far as is known, the highest cancer incidence in the mammalian world is found in mice. This is particularly true of mammary cancer which in certain strains, may affect 100 per cent of the females and, if they receive estrogen<sup>1</sup> artificially, a high percentage of the males. Because of this latter occurrence, it has been concluded that estrogen possesses cancer provoking properties. It is the purpose of this paper to discuss certain pertinent factors and present further experimental studies regarding the relation of estrogen to neoplasia. The voluminous literature dealing with this subject has been reviewed recently by Taylor Jr and is therefore omitted here.

The fact that a substance manufactured in a mammalian body for the maintenance of normal functions can under certain circumstances, provoke cancer in an organ normally stimulated by it is unquestionably important and deserves careful consideration of its true significance. There can be no doubt that cancer of the breasts of mice, provided this tissue has been hereditarily destined to develop cancer, is dependent on the presence of estrogen (18). Comparative studies indicate that the factor of prime importance in this mechanism is not so much *estrogen* as it is *hereditary susceptibility*. Mice, as mentioned show a particularly high tendency to mammary cancer. Rats on the other hand, possess an equally great immunity to this form of cancer although they are subject to mammary adenofibromas which have shown malignant potentialities in transplantation (5, 13, 14). This evident difference in species susceptibility strongly suggests that the rôle of estrogen in carcinogenesis is limited by certain biological patterns.

The huge mass of information on carcinogenesis which has been accumulating for a period

of years indicates that cancer is not a single disease but a group of diseases, the common aspect of which is the destruction of life. More and more evidence is forthcoming to show that the provocative causes vary with different types of cancer and probably vary in their specificity in different species. On purely experimental evidence it is possible to divide these causes into two or possibly three groups (Fig. 1). One produces neoplasia at the site of first contact such as tar, benzantracene derivatives, and certain parasites and is therefore truly *carcinogenic*. The other incites distant cells to assume a malignant behavior without necessarily producing neoplasia at the site of application which might be called *carcinotropic*. Estrogen and certain viruses possess this faculty. The third an undefinable factor may possess both faculties and would cover the still unexplained cancer provoking action of certain rays. Provocative factors are modified by age and sex and probably by vitamins and enzymes although this is not readily demonstrated. However, it has been shown that vitamin A deficiencies favor metaplasia according to McCullough and Dalsdorf, and enzymes normally necessary for certain cell metabolism disappear with malignant degeneration.

Carcinogenic impulses are either favored or neutralized by a group of hereditary factors. General susceptibility or immunity to malignant neoplasia dominates all other hereditary factors such as species, strain, organ and cell differences which exert a modifying influence in a more specialized sense. Their importance is demonstrated in the oft cited classical experiment of Fibiger on gastric cancer in rats, which proved that it required a specific susceptible host, a specific transmitting vehicle, and a specific cancer provocative to produce cancer in a specific cell of a specific organ.

The mechanism of transmission of hereditary factors is still in dispute. Based on breeding experiments on mice, Little considers this essentially a non-Mendelian mechanism following maternal lines and indicating that the cytoplasm of the egg can transmit characteristics independent of

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<sup>1</sup> The terms *estrogen* and *estrogenic* are used here for all substances having estrus-producing properties as suggested by the Council of Pharmacology and Chem. of the A. M. A. in Vol. 109, page 1222, 1936.

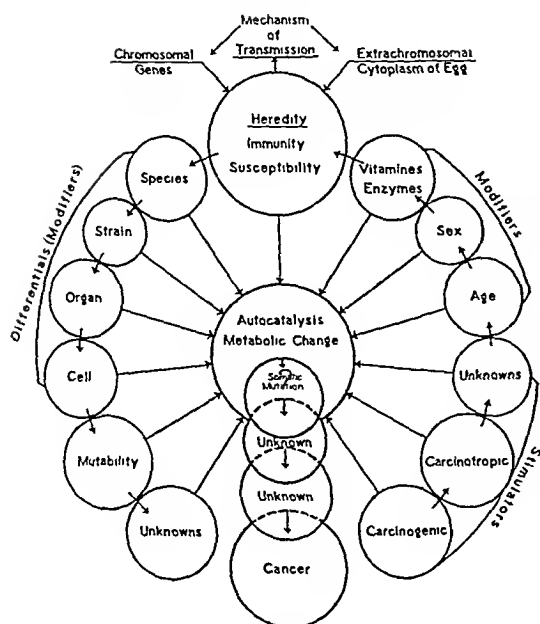


Fig 1 Causes of cancer

chromosomes. This is quite in opposition to Slye's deductions, which favor chromosomal transmission according to Mendelian laws.

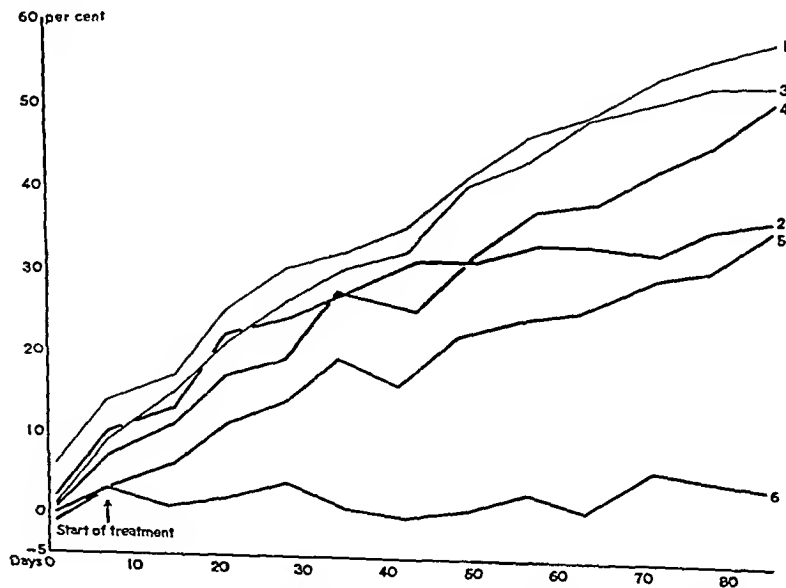
The mutability of cells, i.e., the faculty to change either the physical or functional characteristics, is still an unknown factor. However, since tissues subject to frequent cyclic and

regenerative changes often exhibit unusual catalytic and metaplastic tendencies, mutability may be a factor in carcinogenesis. The existence of other factors not yet demonstrated is taken for granted and grouped under "unknowns." No attempt is made here to explain the mechanism which brings all factors together, which Loeb calls "autocatalysis," i.e., something that generates from within.

The action of estrogenic hormones in relation to mammary cancer in mice conforms remarkably well with the scheme just outlined. Briefly, these hormones incite distant cells (mammary) to undergo malignant degeneration *when hereditarily prepared*, and ordinarily do not produce neoplasia at the site of application. Age and sex modify their action in varying degrees according to Loeb (17), Cori, and Murray. When mammary tissue is not susceptible to cancer it responds to estrogenic stimuli by orderly proliferation which, although extensive, remains definitely limited by physiological capacity.

The secondary modifying factors show themselves in various ways. Thus, duct cells respond far more readily than acinar cells to the carcinotropic influence of estrogen. The importance of the organ differential is expressed by the failure of estrogen to precipitate a malignant reaction in other organs hereditarily destined to develop cancer. Strain differentials are shown by the complete lack of malignant response in breast tissue of certain strains of mice, and species differences are evident from comparative studies of

Fig 2 Chart showing gains in weight. 1, 100 day females unimplanted and untreated, 2, 100 day females unimplanted and treated with theelin in oil 100 international units weekly, 3, 100 day females implanted and untreated, 4, 100 day females implanted and treated with theelin in oil 100 international units weekly, 5, 100 day females implanted and treated with oil 0.1 cubic centimeter weekly, 6, 100 day females implanted and treated with theelin in oil 1,000 international units daily.





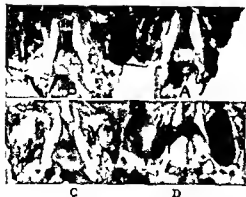


Fig 3 A Normal B 66,000 international units of theelin in 77 days C 13,000 international units of theelin in 85 days D 78,000 international units of theelin in 91 days

mice, rats, and rabbits. The results of certain experiments, attempting through superphysiological stimulation with estrogen to incite the epithelium of the genital tract to uncontrolled hyperplasia, further demonstrate the modifying action of differentials. In mice treated over periods of time with relatively large doses, Gardner, Allen, Smith and Strong, and Sunitzef, Burns, Moskop, and Loeb observed occasional cancer like proliferations in the vagina and uterus in a few animals. Overholser and Allen observed a cancer like lesion on the cervix of 1 monkey in a group treated with theelin and local traumatization. Others (10, 15, 19, 20, 21), studying rats and monkeys under increased estrogen loads, obtained only metaplasias. The difference in end results probably is not due to variations in the estrogenic stimulation but rather to the result of variations in receptiveness of the genital tissues. Compared with mammary cancer the yield of genital cancer, even in susceptible mice, is in

significant. This is in line with the assumption that the relation of estrogen to tissue proliferation depends on biological patterns. The experiments of Perry and Ginzton point in the same direction. These investigators found that in mice of an unpedigreed stock and of unknown origin the combination of 1, 2, 5, 6 dibenzanthracene with theelin yielded a greater number of tumors than dibenzanthracene alone.

Assuming that tissue proliferation produced by estrogen conforms to hereditary biological patterns we have attempted for some time to determine this pattern in a strain of rats entirely refractory to cancer. This strain came originally from a Wistar strain of the University of Chicago, which had been bred at Stanford University since 1928. Breeding females occasionally produce a benign mammary adenofibroma readily transplantable but subject to sarcomatous degeneration (Emge, 5). Although we have transplanted these tumors for nearly 10 years, we have never encountered a carcinomatous degeneration. Since they respond to hormonal stimulation as well as normal breast tissue (Emge and Wulff, 9) it occurred to us that if we could maintain a constant state of lactation it might be possible to invite not only a progressive proliferation of the epithelium but an unusual storage of secretion which, according to Bogen, is a factor in mammary cancer in certain mice. In order to produce this state we destroyed the litters of breeding females implanted with mammary adenofibromas, at birth, and immediately bred them again. By this means it was possible to achieve an almost constant state of pregnancy resulting in immense hyperplasia of tumor and breast tissue (Emge and Murphy, 7). Although the storage of milk assumed relatively great proportions, particularly in the tumors no malignant changes



Fig 4



Fig 5

Fig 4 Vagina normal  
Fig 5 Vagina after 12,000 international units of theelin in 14 days intra cellular edema.



Fig 6

Fig 6 Vagina and cervix after 28,000 international units of theelin in 32 days, vacuolization



Fig 7

Fig 7 Vagina and cervix after 29,000 international units of theelin in 34 days, epithelium down-growth

were observed. With the subsidence of the pregnant state, involution proceeded at a normal rate in the breasts but was considerably slower in the adenofibromas. Animals observed over long periods showed no latent changes in either tumors or breasts. This is not different from the behavior of adenofibromas of the human breast, which involute after lactation at a slower rate than the normal breast tissue. Failure to produce abnormal cell proliferation in adenofibromas storing massive quantities of secretion speaks against retention as a factor in carcinogenesis in this strain of rats.

Having failed to produce abnormal cell proliferation by unusually prolonged spontaneous stimulation, we (8) resorted to the administration of aqueous theelin. Doses approximating or exceeding ordinary physiological requirements were given over long periods to male and female

rats again implanted with mammary adenofibroma. The outstanding result was a fibrosis of the transplanted adenofibroma, a decrease in glandular components with an occasional hyperplasia of the ducts, and a slight proliferation of the same structures in the normal breast tissue *in situ*. We noticed that animals receiving twice the dosage of others produced slightly more epithelial proliferation in both tumor and normal breast epithelium. However, the difference did not warrant the conclusion that the action of the hormone was quantitative. In another experiment, smaller though physiologically excessive doses of theelin were given for longer periods, and we observed still more fibrosis in similar tumors and practically no changes in the normal breast tissue. However, in this experiment 1 tumor was found to have developed a tremendous cystic mastoplasia, which emphasizes the fact that

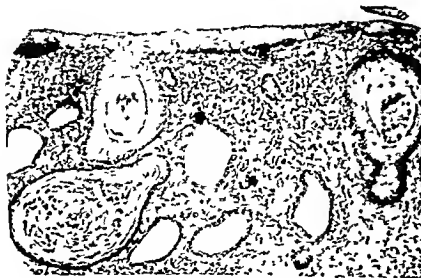


Fig 8

Fig 8 Cervical canal after 44,000 international units of theelin in 50 days, metaplasia of isthmus glands

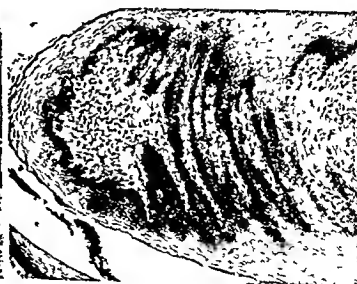


Fig 9

Fig 9 Part of cervix after 53,000 international units of theelin in 62 days, epithelial hyperplasia



Fig 10

Fig 10 Endometrium after 800 international units of theelin in 50 days practically unchanged



Fig 11

Fig 11 Endometrium after 12 000 international units



Fig 12

of theelin in 32 days polyoid hyperplasia

Fig 12 Endometrium after 28 000 international units of theelin in 32 days cystic hyperplasia

qualitative and quantitative differences to estrogen stimulation exist in morphologically similar tissues (Emge and Murphy, 6)

We are now investigating this question in a series of experiments, to be reported in detail at a later date. In the present study, rats 168 days old received 50 international units of aqueous theelin bi weekly for from 20 to 34 weeks. Breast changes were moderate with the usual slight proliferation of duct tissue, but the difference between 20 and 34 weeks of treatment was not very remarkable. In the genital tract however the response of all epitheliums was distinctly different for the 2 periods the longer treatment producing a more massive cornification of the squamous epithelium and a more definite increase in the size of the endometrial glands. Allowing for a possible difference in the effect of the time element on different organs the action of theelin was less quantitative on the breast tissue than on the genital tract.

In order to further clarify this point we are now observing the results of theelin in oil given in doses varying from 100 international units weekly to 1 000 international units daily to a

large group of female rats of different ages implanted with a very glandular adenofibroma. Breast tissue is being removed sufficiently often to obtain information about the progressive action of the hormone. The animals are disposed of at various periods of the experiment and their genital tracts studied *in toto*. We appreciate that the large doses employed are out of all proportion to physiological requirements and do not parallel therapeutic practice. However, having found previously that doses within physiological limits, regardless of the length of time of administration, did not create spectacular changes we felt that we should go the limit in dosage in order to learn if there was any dose which might incite malignant proliferation. We felt that by pushing the dosage we might have a better chance to ascertain limits of immediate response as a basis for quantitative differences. The state of this experiment justifies only the presentation of preliminary observation.

Doses of theelin as great as 1 000 international units daily produce definite physiological changes in our rats within 10 to 14 days. The weight gain stops abruptly as demonstrated in Figure 1 for young animals the hair of the older rats becomes



Fig 13

Fig 13 Endometrium after 44 000 international units of theelin in 50 days metaplasia



Fig 14

of theelin in 62 days destructive stage



Fig 15

Fig 15 Endometrium after 53 000 international units of theelin in 62 days destructive stage



Fig 16

Fig 16 Breast after 500 international units of theelin in 31 days, practically unchanged



Fig 17

Fig 17 Breast after 12,000 international units of



Fig 18

theelin had been given in 14 days, early hyperplasia

Fig 18 Breast after 28,000 international units of theelin in 32 days, hyperplasia, stage of secretion

seedy and the tips of the hair turn brown. Soon the animals refuse to eat and would eventually die if we did not forestall this by selective destruction. Within each group of animals there are individual differences in tolerance, most marked in the older groups. We found that theelin has a lethal limit which, in older animals, approximates 60,000 to 70,000 international units in 64 to 71 days. Younger animals are more tolerant to large doses. Since the injection of oil alone, used as a vehicle for theelin, produces none of these reactions, it must be assumed that theelin alone is responsible. We presume that this is not a direct action of theelin but an indirect result of profound changes in the endocrine system, particularly marked in the pituitary and adrenal glands (3, 4, 28). This is well in line with weight disturbances and atrophy of the ovaries common in the animals studied by us. The hypophysis enlarges rapidly under the influence of large doses and ultimately goes on to adenomatous degeneration. Smaller doses will yield the same result if given sufficiently long as demonstrated in Figure 3. Zondek recently reported that the formation of pituitary adenomas in female rats required about 8 months

of treatment with fairly large doses of estrogen. We obtained the same result with larger doses in 70 days. This, again, speaks for quantitative differences in the action of estrogen.

The changes observed in the genital tract during estrogen stimulation also indicate a quantitative response. In 400 day old rats, one receiving 800 international units in 50 days (Fig 10) reacts much less drastically than 1 receiving 12,000 international units in 14 days (Fig 11), and even still less than 1 receiving 44,000 international units in 50 days (Fig 13). The degree of response of the genital epithelium, therefore, depends not only upon dosage but upon the frequency of administration. These changes in the cervix and vagina (Figs 4, 5, 6, 7, 8, 9) begin with a persistent cornification of the surface epithelium similar to estrus, but more pronounced. This is followed by increased activity and multiplication of cells resulting not only in a thickening of the surface epithelium but in a downward extension of epithelial columns. At the same time, the sharp demarcation between cervical and endometrial epithelium disappears and endometrial glands begin to proliferate. As the estrogen load

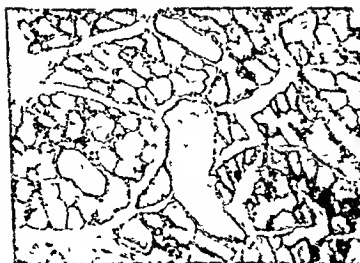


Fig 19

Fig 19 Breast after 29,000 international units of theelin in 34 days, early cyst formation



Fig 20

Fig 20 Breast after 45,000 international units of theelin



Fig 21

in 51 days, vacuolization

Fig 21 Breast after 53,000 international units of theelin in 62 days, physiological fatigue and fibrosis



Fig 22

Fig 22 Adenofibroma donor untreated



Fig 23

Fig 23 Adenofibroma after 28 000 international units of theelin in 32 days hyperplasia



Fig 24

Fig 24 Adenofibroma after the administration of 29 000 international units of theelin in 34 days cystic hyperplasia

is increased, the stratified epithelium of the vagina and cervix becomes edematous and wide spread vacuolization takes place. The endometrium has by now progressed to a state of hyperplasia which suggests polyp formation. The glands are greatly dilated and filled with secretion. Metaplasia of the endometrium next occurs near the cervical junction. At first, only isthmic glands are affected, the endometrial glands having assumed a degree of dilatation very similar in appearance to that seen in functional hyperplasia of the endometrium in man (Figs 10, 11, 12). Progressive metaplasia of the entire epithelial lining of the uterus, which ultimately involves the endometrial glands, marks the height of the reaction (Fig 13). At this point the limit of physiological response is reached and cellular exhaustion is expressed by extensive shedding of the surface layer and the accumulation of polymorphonuclear leucocytes in the uterine cavity, as well as in the glands (Figs 14, 15). Sterile pyometra invariably marks the end phase of the response of the genital tract in this strain of rats. It may be assumed therefore that in the absence of hereditary susceptibility to cancer the physiological pattern,

typical for the behavior of the genital tract of these rats determines the extent and severity of the cellular response beyond which no amount of stimulation will produce further hyper- or metaplasia. This mechanism would seem to be equally important as that responsible for mammary cancer in mice hereditarily destined to develop cancer.

The quantitative differences in response to estrogen are further demonstrated in a comparison of breast tissue *in situ* with implanted mammary adenofibroma removed at different periods of treatment. Here also a biological pattern seems to determine the ability of these tissues to respond to various estrogen loads although not as dramatically as in the genital tract. In both the normal (Figs 16, 17, 18, 19, 20, 21) and the tumor tissues (Figs 22, 23, 24, 25, 26), the height of the secretory response occurs at about 45 000 international units given in 45 days. The various stages of secretory response begin with a simple proliferation of the ducts followed by lobulation. Acini proliferate next and secretion appears. With further proliferation distention of alveoli and ducts, due to the accumulation of secretion becomes evident and cyst formation results. This



Fig 25

Fig 25 Adenofibroma after 45 000 international units of theelin in 51 days cystic mastoplasia



Fig 26

Fig 26 Adenofibroma after 53 000 international units of theelin in 62 days exhaustive stage

is more pronounced in the tumors (Fig. 24) than in breasts *in situ* (Fig. 19), and is probably due to a greater storage of secretion. Cyst formation is followed by fibrosis, again more marked in the adenofibromas, which have a greater abundance of stroma (Figs. 20, 25). Vacuolization of the glandular components precedes minor degrees of metaplasia, which marks the beginning of the end-phase of physiological response. In the breast tissue a slow breaking-down of glandular epithelium marks the lack of further proliferative ability. As far as we have been able to learn, the end-phase of secretory response in the adenofibromas is of a similar nature, but the limited tolerance of the host to large doses of theelin has not permitted us to determine this accurately. As yet, we have not encountered stromal or epithelial changes which would indicate that theelin in oil can incite malignant changes either in the normal breast tissue or in the implanted adenofibromas in this strain of rats. This, in a general way, corresponds with the behavior of the epithelium of the genital tract and confirms the assumption that estrogen, even in extreme doses in a breed of animals protected by an inherent immunity, does not incite malignancy in tissue it normally stimulates.

#### SUMMARY

In a series of experiments on white rats of different ages, in which the dosage of aqueous theelin and theelin in oil were administered in varying dosages and over varying periods of time, no malignant changes were produced in the mammary glands, in the genital tract, or in transplanted mammary adenofibromas. Since this strain of rats is entirely free from spontaneous cancer, it is assumed that a hereditary immunity protects breast and genital tissue against excessive and uncontrolled proliferation regardless of massive doses of estrogen. The proliferative changes observed are quantitative and self-limited, and probably do not occur spontaneously even under high physiological loads of estrogen, as observed in pregnancy experiments. A maximal response to estrogenic stimulation is terminated by a process of cell exhaustion and cell destruction, probably dependent upon changes in the hypophysis due to superphysiological stimulation by estrogen.

Evidence is accumulating to prove that the action of the estrogenic hormones is controlled by definite biological patterns, and that their cancer-provoking faculty in small laboratory animals is strictly limited by hereditary tendencies. There also is evidence that the effect of estrogen on mammary and genital epitheliums is essentially

quantitative. It is again emphasized that the tremendous dosage used in certain of these experiments does not parallel spontaneous physiological processes and far exceeds any clinical usage.

After 2 years of observation on the effects of estrogen stimulation of breast and genital tissue in a strain of white rats free from spontaneous cancer, we have come to believe that the carcinogenic effect of this hormone must be extremely limited. We are not convinced, because estrogen favors spontaneous mammary cancer in mice highly susceptible to this malignancy, that other species of mammalia are likewise affected.

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#### BIBLIOGRAPHY

1. BOGEN, E. The cause of breast cancer. *Am. J. Pub. Health*, 1935, 25: 245.
2. CORI, C. F. The influence of ovariectomy on the occurrence of mammary carcinoma in mice. *J. Exper. Med.*, 1927, 45: 983.
3. CRAMER, W., and HORNING, E. S. Adrenal changes associated with estrin administration and mammary cancer. *J. of Path. & Bacteriol.*, 1937, 44: 633.
4. DIAZ, J. T., PHELPS, D., ELLISON, E. T., and BURCH, J. C. The effects of various gonadotropic substances upon the ovaries, pituitaries, and adrenals of animals receiving long-term injections of estrin. *Am. J. Physiol.*, 1938, 121: 794.
5. EMGE, L. A. Sarcomatous degeneration of transplantable mammary adenofibroma. *Arch. Path.*, 1938, 26: 429.
6. EMGE, L. A., and MURPHY, K. M. The influence of long-continued injections of estrogen on mammary tissue. *Am. J. Obst. & Gynec.*, 1938, 36: 750.
7. Idem. Effect of rapidly repeated pregnancies on transplantable mammary rat adenofibromas. *Proc. Soc. Exper. Biol. & Med.*, 1938, 37: 620.
8. EMGE, L. A., MURPHY, K. M., and SCHILLING, W. Effect of theelin on transplantable mammary rat adenofibromas. *Proc. Soc. Exper. Biol. & Med.*, 1938, 38: 21.
9. EMGE, L. A., and WULFF, L. M. R. The influence of pregnancy on experimental tumor growth. *West. J. Surg. Obst. & Gynec.*, 1934, 42: 45.
10. ENGLE, E. T., and SMITH, P. E. Some uterine effects obtained in female monkeys during continued estrin administration, with especial reference to the cervix uteri. *Anat. Record*, 1935, 61: 471.
11. FIBIGER, J. Ueber eine durch Nematoden hervorgerufene Papillomatose und Karzinomatose Geschwulstbildung im Magen der Ratte. *Berl. klin. Wchnschr.*, 1917, No. 7, *Ztschr. f. Krebsforsch.*, 1914, 14: 295.
12. GARDNER, W. U., ALLEN, E., SMITH, G. M., and STRONG, L. C. Carcinoma of the cervix of mice receiving estrogens. *J. Am. M. Ass.*, 1938, 110: 1182.

- 13 GRAUER R C and ROBINSON G H Pathogenesis of fibroadenosarcoma of the breast Arch Surg 1935 31 677
- 14 HEIMAN J and KREHBIEL O F The influence of hormones on breast hyperplasia and tumor growth in white rats Am J Cancer 1936 27 450
- 15 KAUFMAN C and STEINAMM E Ueber die Wirkung unphysiologischer Mengen Keimdruesen hormonen auf das Genitale weiblicher castrierter Ratten Arch f Gynaek 1938 163 358
- 16 LITTLE C C The present status of our knowledge of heredity and cancer J Am M Ass 1936 106 234
- 17 LOEB L Further investigations on the origin of tumor in mice VI Internal secretion as a factor in the origin of tumor J Med Research 1919 40 477
- 18 Idem Estrogenic hormones and carcinogenesis J Am M Ass 1935 104 1997
- 19 McCULLOUGH K and DALLDORF G Epithelial metaplasia An experimental study Arch. Path 1937 24 486
- 20 McLEVEN C L Metaplasia of uterine epithelium produced in rats by prolonged administration of estrin Am J Cancer, 1936 27 91
- 21 MIGLIAVACCA, A In der Mucosa des Corpus und der Cervix uteri beim Affen hervorgerufene pathologische Veraenderungen Arch f Gynaek 1937 164 463
- 22 MURRAY W S Ovarian secretion and tumor incidence J Cancer Research 1928 12 18
- 23 OVERHOLSER M D and ALLEN E Ovarian hormone and traumatic stimulation of monkey's cervix to a condition resembling early carcinoma Proc Soc Exper Biol & Med 1933 30 1322
- 24 PERRY ISABELLA H and GINTZOW L The development of tumors in female mice treated with 1,2,3,6 dibenzanthracene and theelin Am J Cancer 193 29 680
- 25 SIXE MAURICE Relation of heredity to cancer J Cancer Research 1928, 12 83
- 26 SLATOFF V BLUMS E L MOSKOP M and LOEB L On the proliferation changes taking place in the epithelium of vagina and cervix of mice with advancing age etc Am J Cancer 1938 32 256
- 27 TAYLOR JR, H C The pathology of the ovarian hormone with special reference to its role in tumor development Am J Obst & Gynec 1938 36 332
- 28 ZONDER B Hypophyseal tumors induced by estrogenic hormone Am J Cancer 1938 33 555

# MULTIPLE PLASTIC OPERATIONS IN THE MANAGEMENT OF PROLAPSUS UTERI

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**P**ROLAPSE of the uterus is usually defined as a downward herniation of that organ and is said to be complete or incomplete according to whether the entire uterus protrudes from the vulva or only a portion appears. Most definitions go on to state that there is an associated elongation of the broad and uterosacral ligaments, with relaxation of the anterior vaginal wall and cystocele, together with relaxed and generally lacerated perineum.

These definitions do not sufficiently differentiate the various types of complete prolapse with respect to the nature of the associated lesions, a most important consideration from the surgical aspect, when one must decide what type of operation or operations will best meet the specific indications.

## TYPES OF PROLAPSUS UTERI

The first type considered is prolapse in multiparous women, with relaxation and dilatation of the vagina but without either cystocele or definite laceration of the perineum. This variety of procidentia is not uncommon and has been especially observed among those women with a tendency to ptosis of the abdominal organs. While it is true that in these subjects the bladder does protrude, it is noteworthy that the greater the vesical distention the higher the bladder withdraws into the vagina. The apparent cystocele disappears from sight either wholly or in part. In this variety palpation of the perineum will disclose a fairly firm floor, the sulci uninjured, and the levators competent although more or less relaxed.

The second type is prolapse in multiparous women with marked laceration of both the anterior vaginal wall and the perineum. The cystocele increases in size as the bladder fills and there is a large thin walled rectocele (sometimes with enterocele) indicating profound injury to the muscles and fascia of the pelvic floor.

The third clinical variety is a compound of the first two types, i.e., prolapse with marked cystocele and a firm perineal floor, or the reverse. This compound type is fairly common and the writer

has often been impressed by the apparent integrity of the pelvic floor among women in whom complete procidentia was present with huge cystocele.

The fourth and rarest variety is prolapse of the small uterus of the nulliparous and sometimes virginal woman.

The cause of prolapsus uteri is generally conceded to lie in a stretching and loss of tone of the supports of the organ together with injury to the tissues forming the vaginal canal. With the support being lost, intra-abdominal pressure slowly forces the uterus downward.

The anatomy of the pelvic supporting structures is most complex and so many fasciæ and ligaments have been described that the whole subject has been rendered into a state of confusion. The matter has been condensed and simplified by Frank whose brief and practical summary will be used here. The pelvic organs are held in place by two sets of structures:

1. There is an upper or holding apparatus consisting of those fasciæ and masses of connective tissue occupying the subperitoneal space, i.e., the space between the peritoneum and the levator fascia. This space is entirely filled with connective tissue which may be loose and areolar, or thrown into firm fibromuscular and ligamentous bands. Passing through these masses of connective tissue are found the urethra and vesical neck, the vagina and the rectum, together with blood vessels, nerves and lymphatics. This mass of connective tissue falls into three principal divisions, all originating in the juncture of the cervix uteri with the lateral pelvic wall.

The name, "cardinal ligaments," has been applied to the most important of these divisions but the term is somewhat misleading because no definite ligaments can be demonstrated. The space between the supravaginal cervix and the lateral pelvic wall is filled with a dense mass of connective tissue, the fibers of which form bands of different length and thickness, radiating in a sort of fan shape from the pelvic wall to the cervix and which very firmly connect these structures to each other.

At a lower level similar bands attach the vaginal fornices to the pelvic wall, and higher up



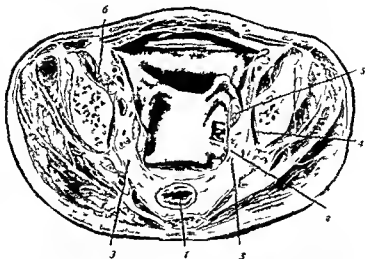


Fig 7 The section passes just below the juncture of sacrum and coccyx through the anterior superior spine of the ilium and the great sciatic notch 1 Rectum 2 peritoneum on lateral margin of cul-de-sac 3 connective tissue of the parametrium 4 obturator internus 5 ovary 6 iliopectineus (Redrawn after Eycleshymer and Schoemaker *A Cross Section Anatomy*)

the connective tissue gradually thins and merges into the peritoneal folds of the lower aspect of the broad ligaments. These connective tissue masses, the so called cardinal ligaments, are the essential structures for holding the uterus in place and, so long as their fibers remain uninjured and unstretched, prolapse of the uterus is impossible no matter what other anatomical defect may be present.

Figures 1, 2, and 3 all represent cross sections of the female pelvis redrawn from *A Cross Section Anatomy* by Eycleshymer and Schoemaker. They illustrate admirably the extent of the connective tissue into which the cervix uteri and the vault of the vagina are set, as it were, and the tremendous importance of these structures in the maintenance of the uterus in its normal station.

The entire levator muscle may be removed and the triangular ligament may be divided, but the uterus will still retain its position provided the cardinal ligaments are intact. It is true, however, that when the lower supporting structures have lost their integrity, long continued intra-abdominal pressure exerted upon the fundus uteri will eventually stretch the cardinal ligaments until prolapse results.

The second group of holding structures is the pubocervical ligaments which are made of fibers of connective tissue extending from the lower posterior surface of the symphysis and pubic rami to the cervix and blending with its wall up to the

level of the internal os. Laterally these fibers merge with the anterior aspect of the cardinal ligaments and are attached also to the true fascia of the bladder and vagina near the median line. These ligaments are strong supports of the uterus but are secondary in importance to the cardinal ligaments.

The third division comprises the so called sacro-uterine ligaments which run from the posterior aspect of the cervix at its junction with the fundus backward and outward to the sacro iliac joints. Their effect in maintaining uterine position has been much overemphasized.

All of the above structures as has been said are designed to hold the uterus firmly in position, their elasticity permitting lateral or anteroposterior movement or even some transitory descent.

2 The supporting tissues of the uterus and adnexa are those of the pelvic diaphragm, the levator ani and coccygeus muscles with their enveloping fasciae and the triangular ligament, which fills in the triangle under the pubic arch and closes the space left by the failure of the two levators to unite anteriorly. This pelvic diaphragm forms a secondary support for the uterus, the muscles by their contraction resist the excessive downward pressure from above and by the maintenance of muscle tone they take at least a portion of the strain of holding the uterus from the cardinal ligament as well as from the associated tissues.

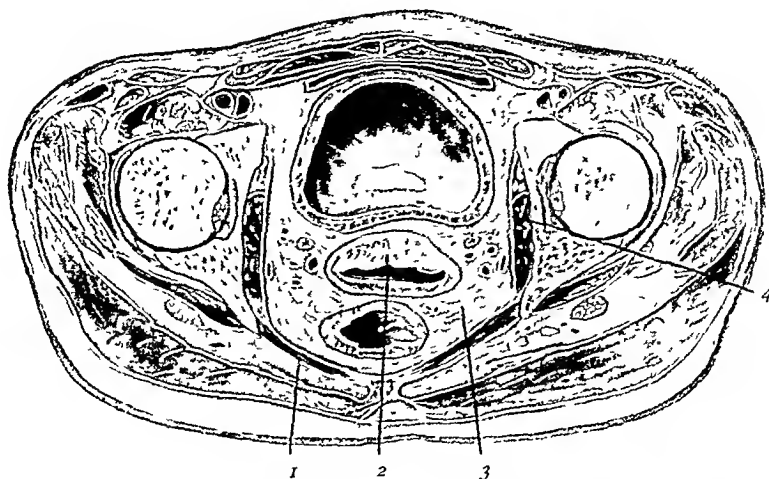


Fig 2 The section passes through the lower part of the coccyx and the spine of the ischium, through the middle of the acetabulum cutting the head of the femur 1, M coccygeus, 2, cervix at level of internal os, 3, connective tissue of the parametrium and cardinal ligaments, 4, fascia of obturator internus (Redrawn after Eycleshymer and Schoemaker *A Cross Section Anatomy*)

#### CAUSE OF PROLAPSE

The cause of prolapse lies in a relaxation of the cardinal ligaments, primarily, the descensus being facilitated by incompetence of the pelvic diaphragm resulting from injury or overstretching. That the holding apparatus is primarily responsible is shown by the fact that many women suffer for years from severe laceration of the pelvic floor with large rectoceles but there is no uterine descent whatever.

Conversely, it is noteworthy how many cases of complete prolapse reveal insignificant injury to the levators and the pelvic diaphragm. The term "hernia" has been applied often to uterine prolapse but the mechanism of this lesion does not seem to justify its use, the process being that of a true ptosis rather than a hernia. The writer has been long in accord with the view that simple mechanical factors are not sufficient to explain the occurrence of procidentia uteri, but that there must be some systemic condition present among women presenting this condition in addition to tissue injuries.

Dr Robert J Griffin, some years ago, made the interesting observation in Kensington Hospital that advanced dental caries was far more prevalent among women suffering from prolapse than in those patients of comparable age who entered the hospital with other pelvic disorders. Whether this phenomenon is merely a coincidence or a true relationship has yet to be shown, and the staff of this institution is now planning an investigation into the question of the metabolism of prolapse

cases in an attempt to throw some light upon the subject.

Defective carbohydrate mechanism as a factor in loss of muscular tone is well known and probably also plays a part in the etiology of prolapsus uteri. This fact has been emphasized by Campbell who presents a suggestive series of blood sugar studies made upon women with birth trauma.

#### MANAGEMENT OF UTERINE PROLAPSE

The non-operative treatment of prolapse, the use of the pessary in women who are bad surgical risks, the question of the type of operation to be preferred in women of child bearing age, pre-operative treatment, and so on are matters of paramount importance, but since this communication is limited to a consideration of certain surgical measures only, the other phases of the subject will not be considered.

Earlier surgical measures for the relief of prolapsus uteri generally included some intra-abdominal procedure as ventrofixation, the fascial interposition of Kocher, or uterine suspension in some form. Gradually the intraperitoneal portion of the operation has been abandoned until now most gynecologists utilize the vaginal approach alone and do not augment the operation by any form of abdominal elevation of the uterus.

The operations for the cure of prolapse in widespread use are: vaginal hysterectomy, the Watkins interposition, the Manchester or Fothergill operation, and the Le Fort procedure.

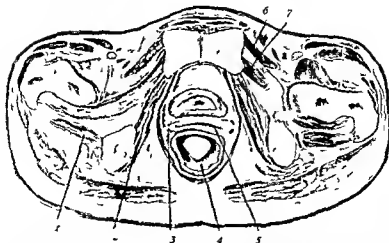


Fig. 3. The section passes through the upper part of the symphysis pubis and the tuberosity of the ischium hence below the external os. 1 M. quadratus femoris 2 in obturator internus 3 connective tissue forming support of vault of vagina 4 rectum 5 vagina 6 m. pectineus 7 m. obturator externus (Redrawn after Eycleshymer and Schoemaker. 1 Cross Section Anatomy)

The choice of operation which will best meet the indications in each particular case is a matter of the utmost importance and it would seem unwise to select one of the foregoing procedures and apply it to a large series of patients without reference to the type of prolapse peculiar to the individual patient. Each patient should be considered individually.

In the clinic of the writer vaginal hysterectomies in general is limited to patients presenting associated uterine lesions as multiple small fibroids, chronic metritis, severe cervicitis and the like. In the treatment of prolapse *per se* this operation plays a comparatively small part. When indicated however, vaginal hysterectomy is of great value, nor is it the purpose of the discussion to minimize the importance of extirpation of the uterus by this means.

It has long been the opinion of the writer that the supravaginal portion of the cervix forms the best foundation or bearing from which to secure support for the ptosed uterus and that such support is more easily obtained when the cardinal ligaments are allowed to remain intact rather than severed from their cervical insertion.

This principle may well be utilized even when hysterectomy is indicated, by performing this operation via the vaginal route but permitting the cervix to remain. In other words, it is a vaginal supracervical hysterectomy. The remaining cervical stump is used as a support for the vault of the vagina.

An operation of this type was performed by the late J. M. Baldy many years ago but was never reported by him. Recently supracervical hysterectomy in prolapse has been excellently described by Richardson who has devised a technique by which the upper segment of the cervix is utilized as a support for the vaginal vault. The reader is referred to Richardson's paper for the details of this important addition to the surgical management of a prolapsed uterus.

Of the three remaining plans of treatment, each controls 1 or more phases of procidentia admirably but fails to correct certain other aspects of the lesion. It is the purpose of this paper to point out the great advantages to be gained by utilizing 2 or even more of the specifically described operations under appropriate circumstances.

#### THE USE OF MULTIPLE OR COMPOSITE OPERATIONS

**Hatkins interposition plus Manchester procedure.** In a case of prolapse of the first type wherein the uterus is in complete procidentia but where neither the anterior nor the posterior vaginal wall has suffered much damage, the descent is produced almost entirely by the relaxation and stretching of the connective tissue supports of the uterus, the cardinal and the supplementary pubovesical and uterine small ligaments. As has been stated, cystocele is a negligible factor in cases of this type. Here the Manchester Fothergill technique gives admirable results because it

shortens and plicates the paracervical connective tissue and elevates the uterus to its proper plane in the pelvis. Under such circumstances then, an operation of one type is sufficient to meet the indications.

In the second type of prolapse, when there has been widespread injury to the anterior vaginal fasciæ and the levator ani, and when cystocele is a prominent factor, the Manchester operation is not so well suited. Even though the uterus be elevated properly, the thinned-out vesical fascia does not offer support firm enough to retain the herniated bladder, and recurrences of the cystocele in some measure is not uncommon if the Manchester procedure be used alone.

On the other hand the Watkins interposition operation is admirably fitted to buttress the weak fasciæ, the corpus uteri forming a plug which serves to close the hernial opening.

However, control of the cystocele is not sufficient. The holding structures of the uterus, the cardinal ligaments, are not affected by this procedure and hence the too frequent failure of the operation. The prolapse recurs even though the anteflexed uterine body continues to restrain the bladder. Under these circumstances the performance of a multiple or composite operation often solves a difficult problem. If a Watkins interposition maneuver is supplemented by a Manchester operation, all of the relaxed tissues will have been restored and all of the indications met.

In the third type of prolapse described, those cases in which either cystocele or rectocele complicates the procidentia, similar composite operations may be performed to advantage.

*Vaginal hysterectomy plus Le Fort operation or partial colpocleisis.* In certain instances when vaginal hysterectomy is indicated for prolapse by reason of some uterine pathology, it is found that the vaginal walls are extremely relaxed and all too often inversion of the vaginal vault a few months after operation renders the patient as unhappy as before. This accident occurs even after the most meticulous technique has been employed and even in the hands of the most accomplished gynecologists.

To avoid this unpleasant sequence, it is often advisable to combine vaginal hysterectomy with a partial colpocleisis or Le Fort operation. Such a plan is especially valuable in old women with marked loss of muscle tone and greatly stretched out vaginal canals. The apposition of the vaginal walls adds but little to the time of the operation and should not contribute to morbidity or mortality.

*Watkins interposition plus Le Fort operation.* Another troublesome form of prolapse is that in which a huge cystocele is attended by greatly relaxed vaginal walls, but the descensus of the uterus is not excessive. This lesion is fairly common among old women and is difficult to correct by any single operation. Here a Watkins interposition will maintain the bladder in position but the relaxed vaginal vault is best held by a Le Fort operation.

Indications for the employment of composite operations will occur to everyone engaged in gynecological surgery and, indeed, multiple operations are doubtless commonly utilized by operators in this field. It must be clearly understood, however, that many cases of prolapse are perfectly manageable by the performance of one of the standard procedures with adequate repair of the pelvic floor and with these cases the present discussion has no concern. However, in any series of operations for the relief of prolapse there are to be found a considerable number of failures, many of which would have been prevented had a composite operation been performed.

It has been thought unnecessary to include illustrations of the various operations under discussion since the technique of these procedures is common knowledge among gynecologists.

#### CONCLUSIONS

- 1 Prolapse of the uterus is due primarily to a relaxation and stretching of the parametrial connective tissue, the holding apparatus of the uterus.

- 2 Loss of tone and injury to the pelvic floor is a secondary factor in the etiology of prolapse. It is operative only because of the unbalance of the forces involved, namely the continuous downward thrust of intra-abdominal pressure which normally should be opposed by an elastic and strong pelvic diaphragm.

- 3 Prolapse cannot occur when the cardinal ligaments and other portions of the holding apparatus are tense and uninjured, regardless of the state of the pelvic floor. It can occur, however, when these ligaments have lost their tone even though the levator ani and associated muscles and fasciæ are comparatively uninjured.

- 4 From the viewpoint of surgical cure, prolapse must be divided into several clinical varieties, dependent upon the associated lesions.

- 5 The upper segment of the cervix uteri and its attached cardinal ligaments offer the best support to the uterus and vaginal vault, and hence vaginal hysterectomy should play but a small part in the surgery of prolapse *per se*. On the other hand, vaginal hysterectomy with the reten-

tion of a collar or disk of cervix (Richardson) is a well designed procedure of great value

6 The utilization of various operative techniques in the performance of multiple or composite operations when required to control prolapse of different types is the method of choice in the approach to this problem

## REFERENCES

- 1 CAMPBELL A D Am J Obst & Gynec 1917 31  
209
- 2 FRANK ROBERT T Surg Gynec & Obst 1917 24  
47
- 3 RICHARDSON E H Am J Obst & Gynec 1937  
34 814

## WERTHEIM OPERATION FOR CANCER OF THE UTERUS

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THE Wertheim operation for carcinoma of the uterus is not a new subject. Over 40 years ago my teacher, Wertheim, originated and developed the technique for this operation and this procedure has been improved further by countless gynecologists the world over. Nevertheless, the fight against cancer of the cervix, which claims thousands of women yearly, continues to stimulate most of us to still greater efforts.

It is my purpose to limit my remarks to a discussion of measures designed to reduce the high mortality rate resulting from the high incidence of postoperative peritonitis. Without doubt the Wertheim technique permits greater exposure, and therefore, a more extensive resection and a more satisfactory examination and removal of involved lymph glands than does any other surgical operation for cancer of the cervix. The Wertheim, therefore, fulfills the primary requirements for successful surgical procedures against cancer anywhere in the body. Despite this, we are obliged to admit that this operation has been discarded in the past few years by many surgeons in favor of other operative or non operative measures due to fear of the attending high mortality, which varies from 10 to 20 per cent with different surgeons, even 30 per cent according to reports in the literature of those patients in whom the Streptococcus hemolyticus could be recovered from the ulcer. The postoperative deaths are due largely to peritonitis. This is easy to understand, for the carcinoma is associated invariably with various pathogenic organisms so that the operation of necessity is performed in a septic field.

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The latest suggestion to reduce the incidence of postoperative infection and peritonitis was made by Louros, of Athens, and presented by him in Amsterdam on May 4, 1938 at the last International Congress for Obstetrics and Gynecology. He modifies an old idea of Zweifel who in order to reduce the possibility of infection resulting from the opening of the vagina from above, recommended burying the uterus deep in the pelvis after its separation from the bladder, rectum and walls of the pelvis, and re-peritonealizing over it with bladder and rectum. The abdomen is then closed, and the patient placed in the lithotomy position. After circumcising the vagina, the uterus is withdrawn and the parametrial wounds are packed. Louros adopted this method with a modification. He employs the mesosigmoid rectum, and mesorectum after closure of the parametrial slit instead of the bladder and rectal peritoneum. After the uterus is removed *per vaginam* he approximates and fixes the surfaces of the plica vesico uterine and recto uterine to the vaginal walls which are then closed. Louros maintains that his modification has these advantages: closure of the peritoneum is facilitated especially if inflammatory areas are present; injury to the bladder and rectum during the preparation of the peritoneal flaps is avoided; and finally, there is no communication between the parametrial wounds and the vagina.

Our method to avoid postoperative peritonitis is altogether different and is based upon the following points:

*The anesthetic.* The entire field of operation must be considered potentially infected. With inadequate anesthesia the small bowel is forced down into the field of operation and may thereby be contaminated. For that matter even the repeated forced reposition of such a bowel will

injure the serosa rendering it less resistant to infection. Moreover, the separation of the rectum from the posterior vaginal wall is especially painful, a manipulation that will prompt the patient to move and to press down even under deep inhalation anesthesia. All this can be avoided only with a truly effective spinal anesthesia. Therefore, when doing a Wertheim operation, we employ spinal anesthesia exclusively, using 8 to 10 cubic centimeters of 0.1 per cent percaine solution, and administer veronal and morphine as pre-operative sedation. Furthermore, this anesthesia effects complete relaxation facilitating gentle and quick manipulation.

*Preparation* Not only the superficial but also the deeper structures of the carcinomatous growth contain bacteria. Each manipulation of the tumor tends not only to force these bacteria still deeper into the uterine tissue but also to infect the entire surrounding connective tissue. For this reason no woman with cervical carcinoma should have a pelvic examination done for at least 2 days prior to the operation. Curettage, cauterization, or tamponade must also be avoided previous to operation. Wertheim, himself, used to curette and cauterize just before operating, believing that he could thereby remove infected and necrotic tissue. Such preparation is not only superfluous but, on occasion, is even dangerous.

*Precautions* To prevent the introduction of infected tissue fragments into the peritoneal cavity from the opened vagina Wertheim used right-angled clamps, the so called "knee-clamps," with which he clamped the vagina below the isolated tumor, dividing the vagina below the clamps. The application of these knee-clamps can be difficult occasionally, especially when the tumor extends far down into the vagina, furthermore, due to inaccessibility it is sometimes difficult to effect division of the vagina below the clamps. Therefore, we discontinued using them and divide the vagina in the following manner. Only after the rectum and bladder have been completely separated and the parametrium resected, so that the carcinomatous growth is supported solely by the vagina, is the vagina painstakingly cleaned with dry gauze from below. Two gauze sponges are introduced into the vagina as high as possible and against the carcinoma, following which, the vagina below this is again cleaned with dry gauze. The surgeon after changing gloves returns to the open abdomen. Grasping the specimen with the left index finger and thumb, and compressing the vagina below the gauze tampons, he opens the anterior vaginal wall with scissors at a level below his fingers. Through this opening then is intro-

duced another gauze tampon into the distal part of the vagina. Following this, division of the vagina is completed. When this technique is practiced it is always possible to prevent the introduction of cancerous fragments into the abdominal cavity.

The results achieved in our carcinomatous patients by the observation of these simple measures can be shown by a brief report of operative results. This routine was employed for the past 9 years, during which time 294 women with carcinoma of the cervix were admitted to our dispensary. Of these, 63 were considered inoperable at once from either physical examination alone or after exploratory laparotomy, and they were referred for irradiation therapy. So, 78.58 per cent of our patients fall into the operable class. In 1932, Halban stated that various surgeons report an average operability of 50 to 60 per cent. It, therefore, appears that our operability rate is rather high due to the fact that we also operate upon very advanced cases.

Two hundred and thirty-one women were operated upon, of these, 152 were operated upon according to the Wertheim technique, 65 according to Schauta-Schuchardt, 2 according to Halban, and 12 had a simple vaginal hysterectomy. The latter 12 were young women, with very early cancer, the diagnosis of which in most of them was established first through biopsy. The 67 patients who were operated upon according to Schauta-Schuchardt, or Halban, were also early cases, in whom the carcinoma was either restricted to the cervix or in whom the growth had extended but very little.

So these patients upon whom a Wertheim operation was performed included not only the advanced cases but also borderline cases. According to Winter's classification most of our patients would be included in Class III and even Class IV. This is proved by some notes taken from the operative findings. In 52 patients enlarged lymph-glands were found and extirpated, during which the obturator nerve in 1, the iliac vein in 6, and the iliac artery in 2 had to be resected because the carcinomatous glands so completely involved these structures that they could not otherwise be removed. In 40 patients it was exceedingly difficult to separate the bladder, it was actually necessary a few times to resect a small portion of it and once even the entire fundus of the bladder. In 33 patients considerable difficulty was encountered in separating the ureters (including 3 resections of the ureter), and in 6 difficulty in separating the rectum. In 11, extensive pelvic inflammatory changes were found, and in 6 patients the tumor

ruptured during the operation despite every precaution taken to prevent this. In 40 patients the parametrium was infiltrated laterally to such an extent that its complete removal exposed even the levator ani.

There were 12 deaths in these advanced cases, a mortality rate of 7.96 per cent. There were 5 deaths due to pulmonary embolism, 2 to pneumonia, 1 postoperative hemorrhage, 1 to the anesthetic, 1 to cerebral edema, 1 to multiple sclerosis, and 1 to retroperitoneal abscess. The deaths due to pulmonary embolism occurred 1, 4, 5, 6, and 14 days, respectively, after operation despite the use of every precaution to prevent it. All were advanced cases in which large, raw surfaces remained due to the very extensive resection. The anesthetic death occurred in a woman whose inadequate spinal anesthesia had to be supported with 100 cubic centimeters of open ether. Here, the autopsy revealed a marked myocarditis. Death, in the patient with retroperitoneal abscess occurred  $3\frac{1}{2}$  months after operation; it is more

than likely that death in this case was due to poor postoperative care rather than to any fault of operative technique. When one considers that all these deaths occurred only in patients with advanced carcinoma of the cervix, the 8 per cent mortality rate is really rather low. At any rate we were able to perform 152 successive difficult Wertheim operations without 1 patient developing peritonitis. These results certainly appear to justify the points of technique mentioned.

I regret that it is impossible to compare our findings with those obtained by Louros with his technique and presented by him to the International Congress in Amsterdam, because the reports of the Congress failed to include his results. However, we believe that our technique saves time and is simpler, because it is unnecessary to change the position of the patient during the operation, thus permitting it to proceed without any interruption. The results obtained by this technique justify its further trial by our colleagues.

# CERTAIN ASPECTS OF SO CALLED STERILITY IN THE FEMALE

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THE problem of sterility is one which concerns not only ourselves as gynecologists, but the general practitioner, the urologist, and the internist. The biochemist and the physiologist, while not directly concerned with the human problem, are able nevertheless to give invaluable aid to the clinician in the study of individual cases. Since distant foci of infection may influence the reproductive tract, even such an apparently remote specialty as otolaryngology may be able to render distinct help.

I should like in this brief communication to deal only with those cases in which the female is entirely at fault, and in whom, on examination, no lesion is apparent or palpable in the pelvic organs. Aldridge reported that 66 per cent of cases of sterility have partial or complete obstruction of the fallopian tubes and that in 44 per cent of these the pelvic examination is negative. It is probably common experience that about one-third of all cases of so called female sterility display no detectable lesion in the pelvis.

There are in this group of cases 3 main causes for the sterility which they manifest. In the first place, there may be no ovulation, in the second place, the liberated ova may be unable to find their way into and through the fallopian tubes, and in the third place, the condition of the reproductive tract in general, and of the endometrium in particular, may be inimical to fertilization, or perhaps more often to the maintenance and implantation of the fertilized ovum and the embryo. Of these 3 main divisions, the second appears to be, superficially at least, an anatomical or mechanical problem, whereas the first and third in many instances are primarily problems in applied endocrinology, since the anterior pituitary hormones exercise chief control over the process of ovulation, and the hormones of the ovary itself regulate the development and activity of the tissues of the reproductive tract.

Occlusion of the fallopian tubes is often due to some mild inflammatory process. It should be borne in mind that peritoneal reaction as a result, for example, of regurgitation of blood through the

tubes in certain cases of abortion, or of irritation of a chemical nature caused by high pressure douches, or even ordinary soap-sud douches, such as are used so extensively in England, may lead to the production of occluding lesions which are not palpable. Tuberculosis must always be borne in mind, not only as a possible cause of sterility, but because of the appalling risks with which it invests procedures otherwise comparatively safe. I am anxious to insist upon this point, since I have seen 3 cases in which, though the history and the physical examination gave no warning, insufflation of the tubes precipitated active pelvic tuberculosis. Recently the lesson was emphasized by a fourth case in which tuberculosis of the endometrium was encountered on examining microscopic specimens of endometrium. Such a finding being pathognomonic of tuberculous salpingitis, a panhysterosalpingectomy was decided upon. When the abdomen was opened the tubes appeared to be perfectly normal, yet on microscopic examination the tubal mucosa was found to be studded with tubercles. In the light of these experiences the use of insufflation, which many employ lightly heartedly either for diagnostic or for therapeutic purposes, should be most carefully considered. The injection of iodized oil, furthermore, is not entirely free from danger (43).

It is to be considered, too, that even when sterility is actually due to tubal occlusion, or in more general terms to failure of the ova to attain the uterus, it is not necessarily futile to attack the problem by endocrinological methods.

Kaufman and others have shown that the administration of estrin not only causes the tubal musculature to develop, but actually leads to an enlargement of the lumen and development of the cilia. Seckinger and Snyder, as early as 1926, found that the activity of the muscular wall of the tube paralleled, chronologically, the changes in the endometrium and tubal mucosa, at mid-interval and for some days thereafter, the contractions were rapid and of varying amplitude, while in the premenstrual and menstrual phases, and throughout pregnancy, they were slower, smaller and more uniform.

In a recent experimental study Geist et al., using the method of Rubin as a means of recording the



tubal contractions, have shown quite conclusively that after the menopause, with the gradual cessation of production of estrogenic hormone, there is a marked impairment of activity of musculature of the fallopian tubes and gradual disappearance of the regular rhythmic tubal peristalsis. Coincident with the impairment in tubal contractility the vaginal smears exhibited signs of various degrees of estrin deficiency. The most marked deficiency was seen in those patients showing least tubal activity. Administration of estrin resulted in the development of rhythmic contraction waves of high amplitude similar to those observed in normal females. Simultaneously with the reappearance of tubal contraction the vaginal smears showed the full effects of estrin upon the mucosa. This excellent experimental study seems to justify our impression (4, 5) that impairment of tubal contractility, due to estrin deficiency, may play a rôle in some form of sterility and tubal pregnancy.

The transporting mechanism in the genital tract deserves further consideration. G. H. Parker has shown that the ciliated epithelial cells in the tubal mucosa waft the ova downward while the contractions in the tubes themselves appear to force the sperm upward. It is not inconceivable that an individual exaggeration of the upward directed force may, first, cause relative sterility by opposing the descent of the ova, second, by permitting premature fertilization or similarly by interference with the descent of the fertilized egg, tend to encourage ectopic gestations whose tendency to recur requires no emphasis, and third, by favoring upward migration of detached fragments of viable endometrium play an important rôle in the causation of endometriosis. From time to time one encounters associations among these 3 phenomena which may have in common some endocrinological etiological factor.

It is also clear that deviation from normal in the endometrium may seriously affect the fertilized ovum before as well as after implantation. Since insemination will only rarely, take place at the very hour when the ovum awaits fertilization, it is most important that the female tract should be hospitable to the sperm. The presence of infection not only in the vagina but in the cervical canal is inimical to the life of the sperm. Such infection may not give rise to purulent discharge, but pathogenic and pyogenic organisms in the vagina have been said to be responsible for some 50 per cent of cases of sterility. Endometritis following the use of the stem pessary is an infection contributing to unsuccessful insemination.

Marshall and Jolly first demonstrated the effect of ovarian secretion on the vaginal mucosa.

The observations of Seguy and Vinneux suggest that the variations which occur in the hydrogen ion concentration and also in the physical character of the cervical secretions throughout the cycle may be of considerable importance in relation to the ascent of the sperm. They observed that at about mid cycle there was an increase in the hydrogen ion concentration and that coincident with this change, the secretion in the cervical canal became less tenacious and more translucent. It is possible that this comparatively simple procedure of testing the character and hydrogen ion concentration of the cervical secretion at different periods of the cycle may be found ultimately to be of value.

One may commence the endocrine investigation of cases of sterility by obtaining a detailed menstrual history. The apparent menstruation of early adolescence is of relatively little importance here since we believe that in many instances these demonstrations are only pseudomenstrual. In the immature rodent, an induced first cycle is usually anovulatory.

It is generally held that the corpus luteum is essential for normal menstrual cycles but I believe that this dogma must be modified as pointed out in a previous communication by Campbell and Collip (6). Moreover, Corner and Hartman have shown that the corpora lutea are not necessarily present in ovaries showing cyclic activity as manifested by menstruation.

Unfortunately pseudomenstruation is clinically indistinguishable from true menstruation. After the patient has reached her menstrual stride, an accurate history should be analyzed as to the length of the interval, the amplitude and duration of flow and the presence or absence of pain.

Sir Henry Whitehouse has stressed the difference between premenstrual pain (dysmenorrhea) and pain (menorralgia) occurring during the actual flow. The latter, in his experience, suggests a foreign body such as polyp, unshed endometrium or leiomyoma in the uterus while he finds premenstrual pain to be associated with a particularly highly developed progestational type of endometrium, the cells in the strata compacta simulating decidual cells, probably produced by too vigorous or too prolonged production of the hormone of the corpus luteum. Excessive duration of flow (over 5 days), or an increasing amount of hemorrhage, must always first suggest the presence of some occult lesion in the uterus or pelvic organs.

The length of the interval is probably the most significant single factor to be gleaned from the personal history. It is unfortunate that many women are convinced that their periods recur regularly

every 28 days, when in fact accurate recording reveals considerable instability. In my experience it is exceptional for a woman whose cycles are shorter than 27 days to become pregnant, it may be that fertilization occurs, but the embryo is aborted on the twenty-seventh day, not having become firmly established before luteal function regressed. The length of the cycle depends upon the complex interactions between the ovary and the anterior pituitary, for, while the anterior lobe hormones determine follicular maturation and the formation of corpora lutea, the hypophysis is itself influenced by the hormones produced by the developing follicle and also by the hormone of the corpus luteum (11). If any link in this chain of stimulation and inhibition is weak, it may well happen that the corpus luteum can not of its own pituitary-controlled vitality sustain the endometrium until the twenty-eighth day of the cycle, until the time, that is, when the corpus luteum may be re-activated and vitalized by *prolan* produced by the developing and implanted embryo. In such cases, the outlook becomes more hopeful if it is found possible to increase the length of the interval, even if only an occasional cycle reaches the desired length, there is always hope that a pregnancy may be successfully established on 1 of these favorable occasions.

More detailed endocrine investigation is a matter of greater practical difficulty, biological assays of estrin and other sex hormones in the urine, or more rarely in the blood, has been practiced with success by Frank et al., Fluhmann (22, 23, 24), and many others, but it demands the services of a competent biochemist, and is vastly expensive both in regard to time and animal material if efficiently done.

To make a really complete survey of the endocrine status of each case, it would be necessary to assay each and every one of the plurality of pituitary hormones, at present an inconceivable task. Furthermore, it emerges from the work of Collip (12, 13, 14, 15) and his associates that to each of these hormones there may be an antagonistic anti-hormone which would also have to be measured quantitatively, there is indeed evidence of the presence of such substances in the blood of many patients with amenorrhea. Moreover, since both the ovarian and the pituitary hormones are produced in fluctuating quantity, biological analysis of single or occasional samples of blood or urine can never fully enlighten us as to the endocrine levels throughout the cycle.

Study of the structure of the endometrium is also open to this objection, that it furnishes only an instantaneous cross-section of a continuously

changing function; nevertheless, valuable information may be obtained in this way. Bland found that in some 23 per cent of sterility cases the premenstrual endometrium strongly suggested anovulatory cycles, Mazer encountered this still more frequently. One may avoid the risk of damaging a healthy endometrium, or even of interfering with an early pregnancy, by obtaining samples within 10 hours of the onset of bleeding. Properly interpreted, the slides reveal fairly accurately the course of events in ovarian activity in the preceding period, though of course only very roughly quantitative evaluations can be made on the basis of microscopic examination.

The time of ovulation can be assumed in a few instances, where it is marked by pain or by slight hemorrhage, but in the majority of cases the determination presents a formidable problem. Sudden increases in excretion of prolactin, and perhaps of estrin, may serve as markers, but the cost and difficulty, as previously mentioned, of detecting them restrict their use. The electrical detection of ovulation of Burr and Allen, requires much elaboration before it can be of practical clinical use. Special attention should be drawn to the most helpful and extremely important work of Venning and Browne (44, 45). They have established a relatively simple chemical procedure for measuring the quantity of pregnandiol excreted in the urine, since pregnandiol is apparently the inactive excretion form of progesterone, the hormone of the corpus luteum, this makes it possible to determine, without too much difficulty, the time when the corpus luteum begins to function as an endocrine organ, i.e., just after ovulation, and to form some estimate of its activity and vigor throughout its active life. Thus in a patient in whom pregnandiol constantly appears at some time other than the fourteenth day of the cycle, one may recommend coitus at or about the time thus indicated. Again, a decreased pregnandiol output in early pregnancy may be regarded as a warning of a threatening abortion, which can possibly be averted by administration of appropriate amounts of progesterone (45). As shown in the recent work of Deanesly and Parkes, there is perhaps the possibility that the implantation of specially prepared discs of crystalline progesterone may afford a practical method of the clinical use of the hormone. However, the appearance of pregnandiol is no certain indication that ovulation as opposed to corpus luteum formation has actually taken place, and of course is no suggestion at all that the ovum is able to pass into the muellerian tract.

Among other aids to endocrinological investigation which have been found helpful, special refer-

ence should be made to the work of Mortimer (34, 35, 36) in using the cranial skiagram as an indicator of anterior pituitary function past and present. While the shape and size of the sella turcica have been widely used as occasional signs of pituitary abnormality, the outline of any ductless gland is of little guide to physiological activity. Mortimer has called attention more especially to the structure of the calvaria and the degree of development of the paranasal sinuses. Since these are largely controlled by the pituitary growth hormone, and since they change in their form and interrelations during the period of growth, they throw light on the previous activity of the pituitary. For example the prognosis is not bright in cases of menstrual disorder or apparent sterility, if there is early cranial sclerosis with poor development of the accessory sinuses.

It is always desirable to remember that the endocrine system functions, as an integrated whole, and that disturbances apparently remote from the reproductive tract may have a considerable bearing on the question of sterility. The net should therefore be flung widely in search of possible causes of this condition. The thyroid gland, for example, has a profound influence on reproduction, and a basal metabolic rate should be obtained in all cases, although one sometimes doubts whether an apparently normal basal rate can be taken as reliable assurance that the thyroid function is perfectly normal.

Abnormalities of carbohydrate metabolism may also serve as indicators of endocrine disorder, it is noteworthy that menstrual cycles are suspended or disturbed in some 50 per cent of diabetic women of childbearing age and reappear when the diabetes is properly controlled (39). Still more important is the fact that sterility is not infrequently associated with disturbances of sugar tolerance which may not necessarily be frankly diabetic in type and that pregnancy may follow the administration of insulin and it should be emphasized that glycosuria may be completely absent and fasting blood sugar levels substantially normal in many individuals whose response to the ingestion of sugar in a tolerance test is altogether faulty and inadequate (38). Some 20 per cent of cases with definitely disturbed carbohydrate metabolism do not show glycosuria. It may be noted here that in these cases, as well as in hyperthyroidism protein catabolism may be increased and thus require an unusually high intake of protein of a high biological or protein sparing value (39).

Nutritional factors indeed, often require some consideration. The normal reproductive rhythm is one of the first bodily functions to become dis-

ordered when the supplies of good quality protein, or of any of the essential minerals or vitamins is inadequate, as the experience of Central European countries during 1916-1919 sufficiently shows. It has frequently been urged, for example that there is a correlation between sterility and secondary anemia. Dr Rolland Kennedy however, in a recent review (unpublished) of mothers attending the child welfare clinic in Montreal found that 43 per cent of a series of 1,500 women of child bearing age showed a relative anemia without any disturbance in their menstrual cycles or interference with pregnancy. Since loss of iron rich blood at menstruation is an important factor in this type of anemia, it is not altogether surprising that there is no correlation apparent between amenorrhea and anemia in a large series of cases.

The endocrine preparations available for therapeutic measures are numerous, but fall into 2 main types as far as their direct influence upon the reproductive tract is concerned. There are first, the ovary stimulating or at least ovary affecting substances obtained either from the pituitary gland itself, or from the serum of pregnant mares or from human placenta or pregnancy urine. There are second, the hormones of the ovary itself and their various natural and artificial derivatives.

In the first group we have made use both of the gonadotrophic or maturity fraction of anterior pituitary extract, and of the anterior pituitary like (19) (APL) fraction from pregnancy urine. Collip et al (16) showed that while both these substances produce luteinization in the ovaries of intact immature rats or mice they are nevertheless, fundamentally different the urinary products are comparatively inert in hypophysectomized animals and apparently require at least the passive co-operation of the animal's own pituitary gland to unfold their usual effects (17) even so, they have relatively little power to produce genuine ovulation (18). We (7) have found that anterior pituitary like is capable of correcting certain menstrual disorders. It is of value in the treatment of cases with moderate intermittent intermenstrual hemorrhage, and tends to re-establish normal cycles when there is persistent uterine bleeding due to endometrial hyperplasia or metropathia hemorrhagica (9). Since many patients have become pregnant during or after such treatment, it appears that though anterior pituitary like may be incapable of producing ovulation on its own account it has no adverse effect. Anterior pituitary like should be reserved for cases with obvious disturbance of the endometrium, while the pituitary gonadotrophic extract is indicated when sterility persists in the presence of more or less

TABLE I—ANALYSIS OF CASES CONSERVATIVELY TREATED WITH EMMENIN

	Cases	
Number of patients treated	34	
Average age of patients, in years	33	
Age of 2 patients at first pregnancy	42	
Years of sterility	2 5	
Average menstrual periods after treatment	1 5	
Number of failures	7	
Number of pregnancies	27	
Pregnancies terminating in abortion	5	
Pregnancies past seventh month of gestation	30	
Stillbirths	3	
Hydrocephalic, 1, abruptio placentæ, 1, death <i>in utero</i> , cause unknown, 1		
Live births	27	
Males	19	
Females	8	
Maximum weight in pounds	11½	
Minimum weight in pounds	6½	
Average weight in pounds exclusive of twins	8 4	
Weight of twins in pounds	Two pairs { Females 5½ and 5½ Males 6½ and 6½	
Average weight in pounds of all live births	8 02	
Method of delivery	Spontaneous	7
	Low forceps	8
	Mid forceps	5
	Craniotomy (monster)	1
	Cesarean section	{ Large babies 5
		{ Abruptio placenta 1
		{ Dead monster (dwarf) 1

normal menstrual cycles, since it is more likely to stimulate true ovulation.

The ovarian hormones, now available in manifold forms, some of them of enhanced potency in practice, have also their part to play. In 1930, Collip (8) obtained from human placentas a water-soluble, ether-insoluble, orally-active factor to which the name "emmenin" was given, it is probable that at least the chief active principle in this fraction is similar or identical to the glycuronide of estriol later isolated from urine by Marian. Emmenin differs from estrone (theelin) in being highly active orally in immature intact rodents (8), but relatively inert in adult castrates. It is with this preparation that I have the most personal experience. The emmenin complex has been found to be of value in the correction of oligomenorrhea (7), even when the menstrual flow, having gradually diminished over a long time, has for some months altogether ceased. On the other hand, suddenly appearing breakage of a previously normal menstrual rhythm is less amenable. In our experience, cycles of normal length are not disturbed by emmenin administration, but in a certain number of cases, short cycles have been lengthened in this way by 1 to 3 days, which probably indicates that emmenin can have a regulating influence upon the pituitary. The normal-

izing of a somewhat short cycle, as already suggested, is often an invaluable step toward overcoming an apparently causeless sterility. Several patients, receiving emmenin treatment for menstrual disorders, oligomenorrhea or dysmenorrhea, became pregnant; still more successful has been the treatment of patients with sterility but with normal cycles. Since in my experience no patient on a cycle persistently shorter than 27 days became pregnant, only those attaining cycles of normal length are analyzed (Table I).

#### SOME POINTS OF INTEREST IN CONNECTION WITH CASES STUDIED

CASE 1 The patient who had been given emmenin became pregnant and continued the treatment for 3 months. She delivered at term by means of cesarean section. One year later the patient again became pregnant but without treatment with emmenin and she aborted after the third month. The following year she received medication for 3 months and at the present writing has been pregnant for 7 months.

CASE 6 This patient aborted in second month probably because of early discontinuance of medication. Later when treatment was continued past the third month she delivered at term. This same occurrence holds true of 2 other occasions.

CASE 12 This patient, a hypophyseal dwarf, began menstruation at the age of 17. It was acyclic, occurring only 2 or 3 times yearly. Emmenin was administered and she became pregnant. A premature male, dead, was delivered by cesarean section in another city.

CASE 14 The patient, suffering with oligomenorrhea, had periods of amenorrhea up to a year throughout menstrual life.

CASE 19 This patient, a chronic nephritic, as later events revealed, became pregnant on treatment but in the last month of gestation abruptio placentæ occurred. She was then sterile for 3 years but became pregnant when treated with emmenin. This terminated in ectopic gestation 6 weeks later.

CASE 20 The past history of this patient disclosed that the first pregnancy terminated as pre-eclamptic toxemia with stillbirth. Two years later she had an ectopic gestation and was then sterile for 2 years. Upon treatment with emmenin she became pregnant and delivered at term. There was no toxemia.

CASE 23 This patient, unipara, was 42 years of age. She vomited throughout pregnancy during which she developed edema, and in the last trimester high blood pressure.

CASE 26 The patient developed moderate edema during the last month of gestation without increased blood pressure. The weight of the child was slightly over 11½ pounds.

Seven patients with no apparent lesion in the pelvis did not become pregnant, later events proved the following:

CASE 23 The patient had pyonephrosis and also pealike submucosal fibroids.

CASE 34 In this patient tuberculosis was present throughout the entire müllerian tract (referred to in text).

Of the 5 cases remaining regarded as failures, no explanation for their sterility can be put forward.

While this series (which extends over a period of 9 years) is small, it would seem that the weights of the offspring of patients becoming pregnant on emmenin are unusually large though from calculated dates there was no evidence of postmaturity. Probably the same pertains when pregnancy follows other similar forms of hormone therapy.

Experience would lead one to suggest that sterility frequently results from deranged function of the muellerian tract as a whole or its transporting mechanism in particular, which in many instances can probably be corrected by emmenin therapy (27-40). It is well to observe here that when women who have previously appeared sterile become pregnant spontaneously, they show a considerable tendency to abort, and this is true also of women who become pregnant during treatment with emmenin. We have however encountered this difficulty only twice since we instituted the practice of continuing the emmenin treatment through the first 3 months of pregnancy.

Maturity fractions of the anterior pituitary gland are reserved for patients who after a 3 months trial of emmenin do not become pregnant and those who after biological investigations appear to be anovulatory.

It is particularly worthy of note that patients who become pregnant while taking emmenin or commence treatment on missing 1 menstrual epoch very rarely have vomiting of early pregnancy or display symptoms of so called toxemia in the last trimester.

## REFERENCES

- ALDRIDGE Quoted by Schmitz Henry Am J Obst & Gynec 1932 21:47
- BLAND P B Quoted by Mazur C Israel L and Kasher L Surg Gynec & Obst 1937 65:30
- BLER H S HILL R T and ALLYN EDGAR Proc Soc Exper Biol & Med 1935 33:109
- CAMPBELL A D Lancet 1932 2:561
- Idem Ann Int Med 1933 7:340
- CAMPBELL A D and COLLIP J B Brit M J 1930 2:1081
- Idem Canadian M Ass J 1930 23:633
- Ibid 22:215, 219
- Ibid 1931 25:0
- COLLIP J B Canadian M Ass J 1930 22:212
- Idem Tr Roy Soc Can Sect V 1932 1:137
- Idem Ann Int Med 1934 8:10
- Idem J Mount Sinai Hosp 1934, 1:28
- Idem Ann Int Med 1935 9:150
- Idem Proc Ass Res Nerv & Mental Dis 1936 2:263
- COLLIP J B, BROWNE J S L and THOMSON D L J Biol Chem 1932 97:171
- COLLIP J B SELYE H THOMSON D L and WILLIAMSON J E Proc Soc Exper Biol & Med 1933 30:590
- Ibid 30:665
- COLLIP J B THOMSON D L McPHEIL M K and WILLIAMSON J E Canadian M Ass J 1931 24:201
- CORNER G W J Am M Ass 1937 89:1838
- DEANESLY R and PARKES A S Lancet 1938 2:666
- FLETCHER C Proc Soc Exper Biol & Med 1933 31:54
- Idem Endocrinology 1934 18:05
- Idem Am J Obst & Gynec 1936 32:612
- FRANK R GOLDBERG M A and SALMON U J Proc Soc Exper Biol & Med 1936 33:615
- GEER S H SALMON U J and WHITE M Am J Obst & Gynec 1938 36:67
- GOLDBERG M B and LISSER H Endocrinology 1935 19:649
- HARTMAN C G Am J Obst & Gynec 1930 19:311
- KAUFMAN C J Obst & Gynec Brit Emp 1935 42:409
- KENNEDY KOLA T W Personal communication
- MARRIAN G F Bio Chem J 1930 24:431
- MARSHALL F H A, and JOLLY, W A Tr Roy Soc B 1906 104:123
- MAZER C and ZISERMAN A J Am J Surg 1932 18:332
- MORTIMER H Proc Ass Res Nerv & Ment Dis 1936 17:222
- Id m Radiol 1917 28:5
- MORTIMER H LEVENE G and ROWE A W Radiol 1937 30:135 and 279
- PARKER G H Am J Obst & Gynec 1932 23:619
- RABINOWITCH I M J Clin Invest 1926 2:585
- Idem J Med Soc N Jersey 1936 Sept
- SCHNEIDER P F Am J Obst & Gynec 1936 31:782
- SECAINGER D L and STYDER F F Bull Johns Hopkins Ho p 1936 39:371
- SEGEV J and VINCENT J Gynec et obst 1933 29:346
- SOLAL R Bull Soc d'obst et de gynec de Par 1932 26:125
- VENNING E H and BROWNE J S L (a) Proc Soc Exper Biol & Med 1936 34:701 (b) Am J Physiol 1936 123:200
- VENNING L H HENRY J S and BROWNE J S L Canadian M Ass J 1937 36:81
- WHITEHOUSE B H J Obst & Gynec Brit Emp 1926 33:627

# MY EXPERIENCE WITH THE MELHADO MANEUVER FOR PERSISTENT POSTERIOR POSITION

GEORGE M. WHITE, M.D., M.C.O.G., F.A.C.S., St. John, New Brunswick

**T**HE delivery in persistent posterior position remains one of the most difficult problems in obstetrics. It tests the judgment and skill of the obstetrician as much or more than any other problem in his practice.

The occurrence of this condition seems to vary somewhat in different parts of the world, or at least the statistics issued by different writers vary. In Eden and Holland's textbook, posterior positions are given as 25 per cent of all obstetrical cases. The figures of Douglas Miller, Edinburgh Maternity Hospital, are 18 per cent. Many years ago the late Professor Williams gave the figures from Johns Hopkins Hospital as 11.3 per cent, and Cragin in a large number of cases at the Sloane Hospital gave the figures as 17 per cent. So you see we have here 4 very reliable sources with the figures varying from 11 per cent to 25 per cent. One is inclined to believe that they are more liable to be underestimated than overestimated. As one is employed in this work he finds that he recognizes more and more posterior positions that rotate spontaneously and do not become persistent. It is probably fairly accurate to say 75 to 85 per cent of all posterior positions rotate spontaneously, so that only from 15 to 25 per cent remain as persistent posterior positions or deep transverse arrests.

You will notice from the heading of my paper that I have no intention of discussing posterior positions as a whole. I am fully aware of the fact that this condition is handled by many men in many ways with excellent results. It was my privilege during my years of training at the Royal Victoria Hospital, in Montreal, to learn this method of handling posterior positions. I believe that it is a good maneuver. I hope to show that the results obtained by others using this method, and more recently my own, compare favorably with the results of any other method used. I do not believe this method should be used to the exclusion of every other method, but I do believe in my own hands it is better for me than any other maneuver. I think every man should use the

method in which he is most skilled and from which he obtains the best results. So I shall not discuss the etiology of posterior positions nor other methods of delivery, but I shall touch on the methods of diagnosis and the importance diagnosis has on the conduct of labor.

In my own private cases I very often can make a diagnosis of a posterior position during the office visits of the last month. Some of these pregnancies are definitely engaged in a posterior position, and some are not well engaged and arouse one's suspicion, as they will in all probability engage in a posterior position. This is a help in the cases at one's office, but often I am called in consultation by an interne with a public patient or by a fellow practitioner with a private patient of his own. I make it a rule, regardless of the time of day or night, that when a patient is admitted to the hospital in labor, to examine her as soon as possible and make a diagnosis as to the position. I believe that this is very important in planning the conduct of the labor.

If I find a breech in the fundus, the resistant plane of the back well out on the right flank with the small parts of the left side well up in front, and much more readily palpable than in an anterior position, the head not well engaged, the cephalic prominence on the left side, the fetal heart well out in the right flank, or sometimes on the left side just near the midline, then I strongly suspect a posterior position. If on rectal examination the head is high and not well engaged, or if the head is engaged and the sagittal suture felt in the right oblique, then my diagnosis is complete.

They are not all as easy as this. Frequently rectal examinations are not satisfactory. If after a reasonable number of hours of good labor I am in doubt of the diagnosis or have not a clear conception of the position, or of the mechanism of labor that is going on, then, under anesthetic with proper sterile technique, I do a vaginal examination. During this examination I try to decide in what diameter the sagittal suture is lying, where the anterior and posterior fontanelles are, the position of the ears, the condition of the cervix, how much it is effaced, and how much it is dilated, and from this examination I am able to decide whether I have a persistent posterior position.

From the Department of Obstetrics, St. John General Hospital.  
Presented in the Symposium on Obstetrics and Gynecology  
before the Clinical Congress of the American College of Surgeons,  
New York, October 17-21, 1938.

The character of the labor often leads one to suspect a posterior position which may not have been diagnosed. Many posterior positions go by the expected date. The first stage is often long and drawn out with a poor quality of uterine contractions and excessive pain in the back. The cervix is slow to efface and dilate and the head remains high. A great many of these cases have the membranes rupture early, so that the first stage of a posterior position is a very unsatisfactory part of labor.

In the diagnosis of posterior positions I always warn my students not to be misled by the position of the point of maximum intensity of the fetal heart. In a right posterior this is most often well out in the right flank, but if deflexion has occurred and the fetal chest is thrown well forward and up against the mother's abdominal wall, it may then be heard best on the left side, very much in the position of a left occipito-anterior. However, this should not mislead us. One always has the x ray to help him, and in cases in which the diagnosis is difficult I have no hesitation in using it.

There is 1 point in regard to the cervix, that I have noticed, which has been a help to me. In anterior positions the cervix, after it is taken up and before dilatation begins, is often very far posterior and hard to reach, whereas in posterior positions this external os is often missed because of the fact that it is so far anterior. So often I have an interne tell me he thinks the cervix is fully dilated because he cannot find the opening, and on rectal examination I find the cervix way up in front almost under the symphysis and not dilated. I have at times missed the diagnosis of a posterior position during the whole of the first stage, until the cervix was fully dilated and the head driven down below the spines, sometimes as a posterior, sometimes as a deep transverse arrest. Then the patient may have strong bearing down pains with the head almost in sight, but showing no pressure on the perineum, no relaxation of the anal sphincter and without proper progress. This is characteristic of a persistent posterior position.

So I use in the diagnosis of posterior positions, first abdominal and rectal examination, then a vaginal examination if necessary, and finally the x ray.

Having made the diagnosis we must now plan the conduct of the labor. During the first stage the patient will require a considerable amount of care and attention. The studied use of sedatives both as to kind and amount is important. As we mentioned before the first stage of labor in these cases is liable to be long drawn out and unsatis-

factory. The patient requires appropriate sustaining treatment as well as sedation. I have found here that the combined use of intravenous glucose and subcutaneous morphine gives excellent results. I think it is important to remember that no interference is justifiable until the cervix is effaced and dilated and the presenting part in the pelvic brim. This is the period of watchful waiting of which we have heard so much.

After these conditions have been fulfilled and the contractions are continuing but progress has stopped or nearly so for  $1\frac{1}{4}$  or 2 hours, it is time to desert our practice of *masterful inactivity* and to interfere, in the interests of the mother and child. If the cervix is not fully dilated but is dilatable and there are signs of fetal distress, it is sometimes necessary to interfere a little sooner than one would if the conditions were better. I think it is just here in the conduct of labor that one has to use his nicest judgment to decide when to interfere and I do not believe there is any one rule that will cover every case. But that as labor progresses and is closely watched, one must decide the most opportune time in the interests of both mother and child.

Dr. DeLee says, 'the posterior position itself, and the operations performed because of it, cause untold and untellable maternal and infant suffering—the child's brains are damaged and the mother's soft parts lacerated and destroyed'.

The following tables give a review of Dr. Melhado's cases as published by him in 1933.

TABLE I—GENERAL REVIEW OF MELHADO'S 976 CASES

	Cases	Per cent
Primiparas	513	52.5
Multiparas	463	47.5
Complete tears	71	7.2
Maternal morbidity	249	24.4
Fetal mortality	44	4.5

There were 976 cases of occipitoposterior position delivered during a period of 6 years at the Royal Victoria Hospital, 513 primiparas and 463 multiparas. There were 71 complete tears, maternal morbidity occurred in 249 cases or 24.4 per cent. The standard of morbidity used was a single rise of temperature to 100.6 degrees, occurring during the puerperium after the first 24 hours. Fetal deaths were 44 or 4.5 per cent. These included stillborn and those that died during the first 2 weeks of life.

The interesting thing to note from Table II is that both the fetal mortality and the maternal morbidity increased with the failure of anterior rotation.

TABLE II—ANALYSIS OF 392 SPONTANEOUS DELIVERIES\*

Procedure	Number	Maternal number	Mortality per cent	Maternal number	Morbidity per cent	Fetal number	Mortality per cent
Anterior rotation	284	0	0	52	18.6	2	7
Face to pubis	108	0	0	33	30.5	6	5.5

\*This represents 40 per cent of 976 cases

TABLE III—ANALYSIS OF 584 OPERATIVE CASES\*

Procedure	Number	Maternal number	Mortality per cent	Maternal number	Morbidity per cent	Fetal number	Mortality per cent
Low forceps	157	2	1.24	37	23.5	4	2.48
Classical midforceps	209	1	.40	58	27.2	16	7.60
Scanzoni operation	67	0	0	17	25.3	5	7.46
High forceps	44	0	0	24	55.5	4	11.10
Melhado maneuver	107	0	0	27	26.1	2	1.80

\*This represents 59.8 per cent of 976 cases

In his summary Melhado has called attention to the following facts: There is a close similarity in the morbidity rate among all forceps operations, the morbidity rate is increased with failure of anterior rotation whether the labor was spontaneous or operative, and the best fetal results, apart from spontaneous anterior rotation and spontaneous delivery, were obtained when the Melhado maneuver was employed.

#### PROCEDURE

It is our custom not to interfere during the first stage of labor, except by those therapeutic methods which aim at the relief of pain. After complete dilatation of the cervix, labor is allowed to progress naturally as long as the head is advancing rapidly. Failure of the head to advance demands immediate determination of the cause and its correction. It is usual in such cases that we find the membranes ruptured, the sagittal suture of the child's head lying in one or other oblique with occiput behind, or in the transverse diameter of the pelvis. Flexion of the head is, as a rule, imperfect, the head being engaged in the pelvis. There may or may not be undue molding, depending on the duration of the second stage. With the whole hand in the vagina, the perineum and pelvic floor are thoroughly dilated. The entire head is carefully palpated, if necessary, to make a correct diagnosis as to the position, the

degree of molding, and the type of head. The head is dislodged completely and pushed up above the pelvic brim. The hand is passed through the cervix beyond the occiput. If any resistance is encountered, such as a contraction ring around the neck, it is carefully "ironed out." The anterior shoulder is palpated and its position determined. If the shoulder appears to be directed forward, it is ignored; if the child's back is found to be directed toward the maternal back, the shoulder is carried forward as far toward the

TABLE IV.—GENERAL REVIEW OF AUTHOR'S 124 CASES

	Number	Per cent
Primiparas	74	59.7
Multiparas	50	40.3
Complete tears	4	3.2
Maternal morbidity	21	16.9
Fetal mortality	0	

anteroposterior diameter as possible. The head is now placed so that it lies with the sagittal suture in the transverse diameter of the brim, the posterior ear resting in the palm of the hand. The back of the hand will then be lying on the promontory of the sacrum. The posterior blade of the forceps is applied along the palm and placed exactly over the posterior ear, with the pelvic curve toward the occiput. The handle of the forceps is held by an assistant to prevent slipping

TABLE V—ANALYSIS OF 124 SPONTANEOUS DELIVERIES

Procedure	Number	Maternal number	Mortality per cent	Maternal number	Morbidity per cent	Fetal number	Mortality per cent
Anterior rotation	61	0	0	10	16.1	0	0
Face to pubis	12	0	0	4	33.3	0	0



TABLE VI—AUTHOR'S CASES DELIVERED BY MELHADO MANEUVER

	No	Per cent
Cases delivered by the Melhado maneuver	50	40.3
Maternal morbidity	7	14.0
Maternal mortality	0	0
Fetal mortality	0	0

during the application of the second blade. The hand is then withdrawn, and the anterior blade is carefully passed across the face of the child until it lies over the anterior ear, i.e., directly opposite the first blade. There can be no possible danger of injury to the bladder during this or any subsequent part of the procedure because all manipulations are done above the brim of the pelvis where there is plenty of room. The forceps are then locked. A gentle movement of 45 degrees rotation is imparted to the forceps, the object of this movement being to bring the occiput to an obliquely anterior position. Every step in the maneuver up to the present time is done with the head free from the pelvic control. The head is now lying within the forceps at the brim of the pelvis; the sagittal suture is in relationship with one of the oblique diameters, and the occiput is obliquely anterior.

With traction, the head is once more brought down into the pelvis. It is astonishing the ease with which the head descends on to the pelvic floor and delivery is accomplished. Usually in this method, the head is brought down in the opposite oblique diameter to that which it originally occupied, i.e., the right occipitoposterior position after rotation to become a right occipito-anterior position and the left occipitoposterior position a left occipito anterior position (the left hand used in right position and vice versa).

In the delivery of my own cases of posterior positions, the results of which I quote below, I have endeavored to follow this maneuver as closely as possible. Certain criticisms of this method have been offered, in that dislodging the head from the pelvis increases the danger of prolapse of the cord. In neither Dr Melhado's

TABLE VII—FETAL MORTALITY RESULTING FROM USE OF VARIOUS METHODS

	Per cent
Cowles	8.06
Dodge	8.33
Cragin	7.66
Hurst	9.00
Green Armytage	8.00

original cases nor in any of my own did this happen. It has also been pointed out to me that in the application of the forceps above the brim of the pelvis, one is doing a high forceps but dislodging a head that has engaged and molded, and bringing it back into the pelvis in a corrected position, is entirely different from dragging a head that has never been engaged into the pelvis.

In conclusion I would like to present two more tables to show a comparison of the fetal mortality results from different methods of delivery of persistent posterior positions.

These are the figures of fetal mortality published by outstanding men in different parts of the world. In Table VIII I present the fetal mortality resulting from different methods of delivery of posterior positions in the Royal Victoria Hospital over a period of 6 years.

My series of cases have been few in number as compared with those of men working in larger places, and they have been scattered over a period of 5 years, and have included both private and public patients. Nevertheless I think the fact that I have not had one fetal death, speaks well for this particular method of delivery.

## REFERENCES

1. CRAGIN E. B. *Obstetric a Practical Textbook for Students and Practitioners*. Philadelphia: Lea & Febiger, 1916.
2. COWLES H. C. Occiput posterior: a case analysis. *Am J Obst & Gynec* Nov 1933 26.
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4. DODGE S. M. The vertex occipitoposterior position: the treatment of more than 500 consecutive cases. *J Am M Ass* 1931 96: 1660-64.
5. EDEN and HOLLAND. *Manual of Midwifery* 7th ed p. 335. New York: The Macmillan Co.
6. GREEN ARMYTAGE A. B. The occipitoposterior: its complications and treatment with observations on the insulin glucose method in shock. *Indian M Gaz* 1927 62: 675-680.
7. MELHADO G. C. The occipitoposterior position. *Am J Obst & Gynec* Nov 1933 26.
8. MILLER D. Occipitoposterior position of the vertex: a survey of 750 cases. *Tr Edinb Obst Soc* 1926-1927 26: 77.
9. WILLIAMS J. W. *Obstetrics* 4th ed p. 295. New York: D Appleton & Co.

TABLE VIII—FETAL MORTALITY AT ROYAL VICTORIA HOSPITAL FOR SIX YEARS

Method	Per cent
High forceps	11.1
Classical midforceps	7.0
Scanzoni	7.4
Face to pubis with spontaneous delivery	5.5
Low forceps	3.4
Melhado maneuver	1.8
Spontaneous rotation with spontaneous delivery	7

# SURGERY ON HANDICAPPED PATIENT

## SURGICAL PROBLEMS IN JAUNDICED PATIENTS

ROBERT S. DINSMORE, M D, F A C S, Cleveland, Ohio

**J**AUNDICE is a symptom and not a disease entity, and because of this one must decide at its onset whether he is dealing with blood dyscrasia, primary disease of the liver or biliary tract, or a mechanical obstruction

The history in this condition is always very important to the surgeon. In addition to ascertaining whether the jaundice has been transient or persistent, a knowledge of the absence or presence of pain and its character, particularly in relation to the jaundice, has been the surgeon's chief aid in making a decision in a large number of his operative cases. The history of previous operations on the biliary tract is disconcerting to the surgeon but, if these have been performed, he must know their exact nature and extent, that is, whether the operation was a cholecystostomy or a cholecystectomy. More specifically he must know how long drainage persisted after the first operation and also the time of appearance of the jaundice in relation to operation. It is a privilege to make the first incision in any biliary operation, particularly in the deeply jaundiced patient.

According to Hartman 25 per cent of all cases of jaundice are due to the gall stone or associated conditions (30 per cent in our own experience), and 30 per cent to carcinoma, either of primary or metastatic nature in the region of the pancreas and ducts. It is also significant that in only 25 per cent of the cases, including both toxic and infectious, is the jaundice due to lesions of the parenchyma of the liver. From these figures, it must be concluded that even a conservative estimate indicates that exploration should be performed in well over one-half of all patients with jaundice. Bitter experience has taught the surgeon that, due to the ever increasing number of drugs in use today, toxic hepatitis should also be considered as a possible cause of jaundice.

Hemolytic jaundice can not be discussed except to state that careful studies of the blood should rule out this possibility. Associated stones, however, may be a complicating factor causing either cholecystitis or obstruction of the common duct.

From the Cleveland Clinic

Presented in the Symposium on Surgical Procedures on the Handicapped Patient, before the Clinical Congress of the American College of Surgeons, New York, October 17-21, 1938.

It is unfortunate that cholecystography is contra-indicated in jaundiced patients. Occasionally, however, a flat plate of the right upper quadrant of the abdomen may be of great assistance in arriving at a diagnosis. The radiologists have stressed the point that these plates should be taken with at least 2 or 3 different penetrations and with the bowels completely evacuated.

In spite of all the refinements in diagnosis, the surgeon still sees certain cases in which an exploratory operation must be done to determine the true cause of the jaundice. In 2 instances during the past year, even after the most complete and exhaustive studies, I have operated and found that each of the patients had a very small atrophic liver which caused the jaundice.

### PRE-OPERATIVE PREPARATION

In general surgery it is becoming increasingly obvious that in many cases of chronic illness requiring surgery, adequate pre-operative periods of preparation are essential. It is no longer good surgical judgment to send such patients into the hospital one day and operate the following day. The lowered mortality rates following the use of a careful pre-operative routine in many special fields bears testament to this fact, which was probably first emphasized by the men doing thyroid and genito-urinary work. Many lesions of the gastro-intestinal tract, such as dilatation of the stomach, chronic obstruction, and all conditions of the colon, as well as many cases of chronic disease of the chest, were formerly considered as emergencies, but now the patients are prepared for operation over a period of several days. This is particularly true of the jaundiced patient if a low mortality rate is to be maintained. Unquestionably, this factor has been more important than improvement in operative technique. Ordinarily it requires from 4 to 7 days and, as a general rule, it is better to extend the pre-operative period than to shorten it if the patient is improving.

The surgeon is primarily interested in the degree of liver damage which has taken place, for he recognizes that a chronic infection of the intra-hepatic ducts must be considered as an almost

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Hemolytic jaundice can not be discussed except to state that careful studies of the blood should rule out this possibility. Associated stones, however, may be a complicating factor causing either cholecystitis or obstruction of the common duct.

It is unfortunate that cholecystography is contra-indicated in jaundiced patients. Occasionally, however, a flat plate of the right upper quadrant of the abdomen may be of great assistance in arriving at a diagnosis. The radiologists have stressed the point that these plates should be taken with at least 2 or 3 different penetrations and with the bowels completely evacuated.

In spite of all the refinements in diagnosis, the surgeon still sees certain cases in which an exploratory operation must be done to determine the true cause of the jaundice. In 2 instances during the past year, even after the most complete and exhaustive studies, I have operated and found that each of the patients had a very small atrophic liver which caused the jaundice.

### PRE-OPERATIVE PREPARATION

In general surgery it is becoming increasingly obvious that in many cases of chronic illness requiring surgery, adequate pre-operative periods of preparation are essential. It is no longer good surgical judgment to send such patients into the hospital one day and operate the following day. The lowered mortality rates following the use of a careful pre-operative routine in many special fields bears testament to this fact, which was probably first emphasized by the men doing thyroid and genito-urinary work. Many lesions of the gastro-intestinal tract, such as dilatation of the stomach, chronic obstruction, and all conditions of the colon, as well as many cases of chronic disease of the chest, were formerly considered as emergencies, but now the patients are prepared for operation over a period of several days. This is particularly true of the jaundiced patient if a low mortality rate is to be maintained. Unquestionably, this factor has been more important than improvement in operative technique. Ordinarily it requires from 4 to 7 days and, as a general rule, it is better to extend the pre-operative period than to shorten it if the patient is improving.

The surgeon is primarily interested in the degree of liver damage which has taken place, for he recognizes that a chronic infection of the intra-hepatic ducts must be considered as an almost

From the Cleveland Clinic  
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constant factor in obstruction accompanying cholelithiasis. The surgeon wishes to know specifically the following points about the patient upon whom he is to operate: (1) the function of the liver, (2) the level of the serum bilirubin, (3) the coagulation time of the blood, (4) renal function studies, (5) the roentgen findings in the flat plates of the right upper quadrant, and (6) if a postoperative fistula is present to have cholangiographic studies.

We know that patients who are suffering with jaundice have a tendency to bleed after operation but as Mason has stated, no test has yet been devised which can be relied upon to indicate that postoperative bleeding will not occur. Although there is some controversy as to whether the lack of available calcium is one of the factors in this hemorrhagic tendency, I still feel that the administration of calcium should be a part of the preoperative routine. We are indebted to Lee and Vincent, Whipple, and Walters particularly for repeatedly emphasizing this precaution and recommending that 5 cubic centimeters of the 10 per cent solution be given each day during the entire preoperative period.

Unquestionably the most important preoperative procedure is the transfusion of blood, at least a transfusion of 750 to 800 cubic centimeters each being required. Following this treatment, the direct beneficial effect is apparent by improved appearance in the general condition of the patient and the lowered coagulation time of the blood.

The factor of dehydration must also be borne in mind. This can be remedied by the use of a 10 per cent solution of glucose in normal saline given either subcutaneously, intravenously or both as necessity dictates. The diet should be rich in carbohydrates. Ordinarily we encourage these patients to eat large quantities of hard candy. It is not within the scope of this paper to discuss the so-called liver deaths but Graham's work is strong evidence that the chief factor in the prevention of this catastrophe is an adequate store of glycogen.

In the light of the recent work of Snell and his coworkers estimations of the prothrombin level and the prothrombin time will undoubtedly be added to the preoperative routine as will the treatment with the newly isolated vitamin K, which has a marked effect upon the jaundiced patients who have a deficiency of this substance.

#### TESTS OF LIVER FUNCTION

The tests of liver function are generally unsatisfactory because the liver has such a large

reserve that even quite marked structural changes do not produce an alteration of function as gauged by the tests now in use. The tests we have used are: (1) bromsulphalein retention in plasma after intravenous injection, (2) galactose tolerance test if jaundice is present, (3) Takata Ara test in blood and in ascitic fluid in the presence of ascites, (4) special blood studies to determine the volume and shape of the red blood cell and the degree of anemia and (5) determination of total blood protein.

The bromsulphalein test is the most sensitive of all tests now in use but it is not satisfactory in the presence of obstructive jaundice. The galactose tolerance test is not a sensitive one and has little practical application in liver disease. The excretion of galactose may be impaired if the jaundice is due to liver disease but the test gives normal findings if the jaundice is due to simple obstruction.

The Takata Ara test is positive in a number of types of liver disease but is most frequently positive in cirrhosis, a negative test being strong evidence against the presence of cirrhosis. If ascites is present and the test is positive in the ascitic fluid, the accumulation of fluid can usually be attributed to cirrhosis. These same observations are true in regard to the determination of the total blood proteins.

If there is liver damage anemia is a common finding. Here the red cell is nearly always larger than normal so a macrocytosis of the red cells is suggestive of disease of the liver parenchyma. If there is obstructive jaundice due to disease of the bile ducts a flattening of the red cells occurs without an increase in volume.

The change in the red cells seems to be the most sensitive index of liver function but these studies must be repeated frequently to be of clinical significance. The most useful test is the bromsulphalein test. The Takata Ara test is simply done and may give valuable information.

Surgeons are often confused by the various methods used in determining the coagulation time in severely jaundiced patients. In our experience all stab and puncture methods have been considered to be unreliable due to the fact that the blood has been squeezed through the tissues. For that reason we have discarded all such procedures and use routinely the White and Lee method which requires 5 cubic centimeters of venous blood, 1 cubic centimeter being placed in each of five 8 millimeter tubes. The first tube is tipped at 4 minutes and the others at the same interval. If the coagulation is not complete in 5 to 8 minutes it is considered abnormal, thus giving an actual

accurate coagulation time. A knowledge of the bleeding time has not been of much clinical assistance.

**Cholangiography.** Cholangiographic studies will undoubtedly come to be recognized as a definite adjunct in the management of a certain number of patients with fistulas and persistent jaundice. A large bibliography has been accumulated on the subject, and Best and Hicken within the past few years have emphasized its use and importance, either as an immediate procedure at the time of operation, or postoperatively when a fistula is present or a T tube is in place. In certain cases there is some question at the time of operation as to the cause of the obstruction. From their studies these writers have shown that an occluded cystic duct may be the cause of the rather high mortality rate and of some of the failures following a cholecystostomy or cholecystogastrostomy in jaundiced patients. It is not indicated, however, as a routine in the uncomplicated cases. If these plates can be taken while the patient is on the operating table and the opaque substance passed into the gastro-intestinal tract without obstruction, the abdomen may be closed with complete assurance of the patency of the common duct. They believe that cholangiography reveals many stones which could not be felt by palpation or direct visualization. In individuals who have had drainage with a T tube or who have a persistent fistula, cholangiography is undoubtedly of great value in showing the presence of the choledochal stones, strictures, or tumors.

**Cholecystostomy or cholecystectomy.** Cholecystostomy still has a definite place in the handling of deeply jaundiced patients. True it is that the field is limited, but no hesitancy should be shown in doing a cholecystostomy in a severely ill, elderly patient with a rapidly developing jaundice. When a stone has become impacted in the ampulla, the stone may be seen occasionally in a small pouch at the neck of the gall bladder. It is often accompanied by acute inflammation of the surrounding area, acute cholangitis, and an empyema of the gall bladder. In several such cases the removal of the stone and cholecystostomy have been life-saving measures. Likewise, in a severely ill patient with jaundice and stones in the common duct and the gall bladder, it may be unwise to perform a cholecystectomy instead of draining both the gall bladder and the common duct. I believe that it is a dangerous dictum to state that a cholecystectomy is always indicated. One of the striking features about some of these cases is a marked thickening and edema of the serosa of the gall bladder. For many years one of my asso-

ciates, Dr. William E. Lower, has used a modified cholecystectomy in this group of cases. After opening the dome of the gall bladder and removing the stones, a line of cleavage between the serosa and the mucosa is easily delineated and the mucosal surface stripped out, which at times looks almost like a cast of the gall bladder. This procedure in the proper case has the advantage of being done quickly without leaving a raw, bleeding surface on the liver bed. Dr. Lower has never been obliged to do a secondary operation on any of these patients, and he is favorably impressed by the little postoperative reaction which these patients experience.

The indications for cholecystectomy are well understood. The operation in the deeply jaundiced patient depends upon the local inflammatory reaction and the general condition of the patient. Most surgeons agree that the best type of drainage, after removal of the stones in the common duct, is secured with a T tube, the limbs of which have been shortened and a notch placed on the posterior side so that it can be removed easily. This has been far more satisfactory than the insertion of a straight catheter toward the liver, attempting to sew it and hold it in place with sutures. Undoubtedly these catheters have, on occasion, unknowingly been inserted in the distal side. It is also much easier to approximate the duct accurately about the T tube than around a straight catheter.

The short-circuit operations of the gall bladder to the stomach or duodenum, on the whole, have been unsatisfactory. If possible, it is preferable to anastomose the gall bladder to the duodenum rather than to the stomach. If the anastomosis functions properly, it often gives relief from the intolerable itching of which the patients complain, and quite frequently immediate relief is secured from the deep, boring pain which the patient with a chronic pancreatitis or carcinoma of the pancreas experiences. The opening need be only a small one, and in the deeply jaundiced patients we have felt that silk may be used to advantage on the serosal surface. In doing the operation it is a great comfort to see colored bile returning from the gall bladder after the thick tenacious material has been evacuated. Oftentimes it is difficult in some of these cases, even with adequate exposure, to know whether you are dealing with an inflammatory or a neoplastic process.

Best and Hicken have pointed out that the high mortality in these patients has been due to the obstruction caused by the inflammation, neoplasm, or stone which has been overlooked, and

this of course is a forceful argument for the use of cholangiography while the patient is on the table

#### OPERATIVE PROCEDURE

I feel that in my own hands gas oxygen anesthesia augmented by ether has been most satisfactory. We are concerned with an anesthetic which can be given with a minimum of damage to the liver and at the same time give adequate relaxation. Any type of deep anesthesia particularly with severely jaundiced patients, is to be avoided. I have used spinal anesthesia occasionally but still prefer not to use it in the upper abdomen although it may be of advantage in secondary operations upon the common duct.

Incisions for gall bladder work are largely a matter of choice. It is always interesting to note that most surgeons, after trying all the different approaches usually return to the right rectus incision. In this connection one point has been a particular help to me and that is in being careful that the incision is high enough. Dr. Judd always placed particular emphasis upon the importance of carrying the incision as near the costal border as possible. In general it can be stated that surgery of the deeply jaundiced patient is for the most part difficult. Lord Moynihan stated that the surgery of cholelithiasis as a general problem was difficult sometimes extremely difficult and he held it to be of greater technical difficulty and to present more problems for accuracy of judgment than any other branch of surgery. This is particularly true in the obstructive case of jaundice which is either persistent or has occurred after a surgical procedure. One always hopes that it is due to stones in the duct and not to a stricture or injured duct. A great deal of emphasis has been placed on the various types of anastomoses either on repair of the duct or its anastomosis to the gastro-intestinal tract. Little emphasis has been placed on the isolation of the structures with which to do an anastomosis. After all the great difficulty is in finding the proximal side of the injured duct. Unquestionably the ideal procedure is to anastomose this to the duodenum and not attempt any plastic surgery on the duct itself.

#### POSTOPERATIVE CARE

From this discussion it is quite evident that the pre-operative care of these patients is of primary importance if they are to have a smooth post-operative convalescence and avoid the complications so common in the unprepared jaundiced patient. There are a few points that may be mentioned about these patients after operation. It is

important at the onset to be prepared to do a transfusion at any time and to have adequate donors available. Occasionally bleeding may occur 8 to 12 days after the operation in a patient who is apparently doing well. With this in mind measures to combat the hemorrhagic tendencies should not be discontinued too soon. In most instances it is advisable to do a transfusion immediately after the operation. Ordinarily these patients are much more comfortable in a semi-Fowler's position and when given continuous intravenous glucose and saline solution for the first 24 to 48 hours. This insures an adequate intake of carbohydrates and fluids. Many of these patients are more comfortable in an oxygen tent for the first 24 hours after the operation and in addition to the easier respiration, the general appearance of these deeply jaundiced patients is improved. If a T tube has been inserted, it is advantageous to clamp the tube for 1 or 2 hours at a time as soon as possible oftentimes on the third day, to prevent an abnormal loss of bile. The question as to when the T tube is to be removed rests largely with the individual case for it will likely be an established routine to do a cholecystogram on many of these patients before the tube is removed. The tendency now is to leave these tubes in longer than formerly.

#### CONCLUSION

These cases then represent a group who present definite difficult problems in diagnosis and operative technique and if a low mortality rate is to be maintained they must be handled as bad risks, carefully prepared before and carefully watched after operation.

#### REFERENCES

1. BEST, R. R. and HICKEN, N. F. Cholangiography. *Surg. Gynec. & Obst.* & *Internat. Abstract Surg.* 1935 66 126-131.
2. GRAHAM, E. A., COLE, W. H., COPPER, G. H. and MOORE, S. Diseases of the Gall Bladder and Bile Ducts. Philadelphia: Lea & Febiger 1938.
3. HARTMAN, H. R. A study of the cause of jaundice in 400 cases. *Med. Clin. N. America* 1928 11 1583.
4. LEE, R. J. and VINCENT, B. The relation of calcium to the delayed coagulation of blood in obstructive jaundice. *Arch. Int. Med.* 1915 16 59-66.
5. MASON, R. L. Pre-Operative and Post-Operative Treatment. Philadelphia: W. B. Saunders Co. 1937.
6. SWEET, A. M. Symposium on hemorrhagic diathesis in cases of jaundice: its relation to vitamin K deficiency. 190 Staff Meet. 1935 Clin. 13 65-67.
7. WALTERS, W. Pre-operative preparation of patients with obstructive jaundice. *Surg. Gynec. & Obst.* 1931 33 651-656.
8. WHIFFLE, A. O. Surgery of the biliary tract. *Surg. Clin. N. America* 1931 1 373-389.

# MEDICAL ASPECTS IN PRE-OPERATIVE AND POSTOPERATIVE CARE OF DIABETIC AND CARDIAC PATIENTS

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IN APPROACHING an understanding of what is to be and what can be accomplished in patients with diabetes mellitus or heart disease, from a medical point of view, it is necessary to have a clear understanding of the problems involved based on physiological, physical, and chemical facts, in order to justify any form of therapy. It is known that these disabilities increase the hazard of surgical procedures, but these hazards can be greatly diminished if there is a definite understanding of the existing condition by those who are vitally concerned in the success of a completed program.

I wish to stress the importance of a complete understanding of the problems involved in these handicapped patients by the anesthetist, the internist, and the surgeon. Working co-operatively, they offer the greatest security to these patients. In my opinion the anesthetist is not only a very necessary member of this group, but one to whom the internist and the surgeon look for help. He should be a well trained physician who has devoted time and study to his specialty and who has had sufficient clinical experience to detect and to evaluate correctly changes occurring in a patient during anesthesia. From his training and experience he is capable of advising the anesthetic of choice and the degree of anesthesia to be produced. What a comfort such an anesthetist is to the surgeon whose mind is free to perform the necessary operation as expeditiously as possible with a minimum of trauma, and to the internist who knows that his physically handicapped patient is in the hands of an understanding person. With such a group, surgical problems are approached with greater confidence and safety which otherwise are unobtainable.

Ordinarily patients with diabetes and those with heart disease present for solution problems which are in nowise related. After 50 years of age both groups develop mutual problems. It is generally known that patients with diabetes are much more likely to develop arteriosclerosis and

its complications than an equal number of patients of the same age group with other diseases. After 50 years of age the number of patients with heart disease seeking surgical relief will be found to have impairment of their circulatory mechanism, most frequently because of arteriosclerosis. The diabetic offers the greatest difficulty of these 2 groups because he has not only diabetes but also arteriosclerosis, whether the latter is demonstrable or not.

## PATIENTS WITH DIABETES MELLITUS

The mild diabetic requiring immediate surgery becomes a patient with a potentially serious handicap, the seriousness depending upon the nature of the disease requiring surgical relief. Infection of any kind is most dreaded in a diabetic because it not only makes his disease worse but if uncontrolled leads to acidosis, coma, and death. It is most essential, therefore, for the patient and the internist to recognize the onset of infection at the earliest possible moment, and if amenable to surgical relief, to seek this as promptly as possible. Prompt treatment of infection helps the diabetic to rid himself more quickly of a pathological lesion which makes his disease worse. With our present knowledge of diabetes, our expert physician anesthetist, and with such wonderful surgical skill and experience in treating infection, the diabetic mortality from this cause should greatly decrease, provided we teach our patients to seek help early.

In acute surgical emergencies, arising during the course of diabetes, too much stress cannot be laid upon the necessity of quick operative relief. Delay in seeking this relief may, and frequently does, forfeit whatever chances the patient has for complete recovery.

## PRE-OPERATIVE CARE

Those diabetics who do not require emergency surgery present certain problems of importance in their pre-operative preparation. The object of such care is to obviate the possibility of acidosis to prevent other complications which might arise, and to hasten convalescence. In the care of pa-

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tients belonging to this group there are certain considerations which are of value in order to accomplish the desired results

1 To store glycogen in the body sufficient to supply the patient's needs during the period of operation and for several hours thereafter This is accomplished by feeding in the previous 24 hours at least 150 grams of carbohydrate and by controlling glycosuria by the administration of insulin in the necessary dosage at 2, 3 or 4 hour intervals

2 Giving a sufficient amount of fluids to take care of the body needs which ordinarily would amount to 2,500 or 3,000 cubic centimeters administered as water, broths fruit juices oat meal gruel, tea or coffee etc

3 It is desirable to administer easily assimilable foods in the form of carbohydrate until at least 4 hours before the time of operation

4 The established dose of insulin is continued without regard to the operation the only difference being a change in the time of administration If a diabetic is receiving protamine insulin and most of them are, this should be continued and supplemented when necessary with small doses of regular insulin every 3, 4, or 6 hours as the occasion demands The dose required is determined either by the presence of sugar in the urine or an increasing blood sugar

5 If the diabetic is an individual who is not under good control it is far better to have, if time permits dietary and insulin adjustment before operation is undertaken The diabetic is much safer if he goes to the operating room with a urine sugar free and a blood sugar which approaches normal

6 In acute surgical emergencies, which are usually accompanied by marked acidosis as evidenced by a lowering of the carbon dioxide combining power of the blood plasma, and the detection in the urine of diacetic acid as well as glucose, the immediate needs of the patients must be met by giving a sufficient amount of regular or quick acting insulin the administration of normal salt solution subcutaneously or intravenously cleansing the lower bowel with an enema and washing the stomach with plain water Such treatment followed in a regular and orderly manner over a period of a few hours will diminish the operative hazard and promote recovery

Little Mary Jane a well trained diabetic 10 years old living in a neighboring town developed an acute otitis media The ear drum was promptly punctured by her physician but fever continued glycosuria increased and the infection spread so that 36 hours later the mastoid was involved Despite increasing doses of insulin sugar and diacetic acid excretion steadily mounted and rather quickly

she developed a marked acidosis She entered the hospital with a temperature of 104 degrees F marked tenderness over the right mastoid and a thin purulent discharge from the right ear The urine contained 4.8 per cent of sugar the blood sugar was 383 milligrams per cent and the carbon dioxide combining power of the blood plasma was 20 volumes per cent She was given larger doses of insulin subcutaneously and immediate preparation made for operation Her stomach had previously been washed and she had received an enema before entering the hospital It was only necessary to give her salt solution by hypodermoclysis which was continued during the operation A mastoidectomy was done under nitrous oxide oxygen and local anesthesia Within 3 hours after her arrival in the hospital she had received treatment for her infection and her acidosis and within 3 days was well on her way to an otherwise uneventful recovery

7 In so far as possible it is extremely beneficial to allay the fear and anxiety of operation in patients who are afflicted with diabetes by the preoperative administration of suitable doses of the barbiturates and also when it is found necessary, the use of small doses of an opiate with scopolamine In my experience, this procedure has been most valuable and has been a great comfort not only to the patient but to the anesthetist and surgeon as well

#### POSTOPERATIVE CARE

In dealing with this phase of the discussion I feel it necessary to direct attention to 4 problems (1) Upon the return of the diabetic to his room be should at once receive fluid, preferably normal salt solution containing 2.5 per cent of glucose, administered subcutaneously and if not contra indicated by the nature of the operation at least 500 cubic centimeters of salt solution by rectum (2) The patient should be given small but frequent doses of regular insulin, the size of the dose and the frequency of administration depending upon the severity of the diabetes and the patient's preoperative condition (3) Every attempt should be made to begin feeding the patient by mouth as soon as possible after operation Our experience has demonstrated that it is possible to start this in the great majority of patients within 4 to 6 hours after the return of the patient to his room Such foods as oatmeal gruel ginger ale, fruit juices, tea or coffee with glucose and crackers are given Within the first 24 hour postoperative period an attempt should be made to furnish at least 100 grams of glucose either subcutaneously or by mouth with a sufficient quantity of insulin to keep the urine approximately sugar free (4) Constant stock taking and supervision of the sugar metabolism by employing frequent urinalyses and occasional blood sugar determinations are most essential for the intelligent handling of these patients

## PATIENTS WITH HEART DISEASE

It has been customary among the laity and among physicians to suppose that in perfectly normal individuals, anesthesia in particular and surgical operations in general, impose a terrific burden on the heart and circulation. Such an assumption most likely arose as the result of impressions received in the early days when the administration of an anesthetic, usually ether, was accompanied by marked excitation, struggling, periods of apnea, cyanosis, increase in blood pressure, and increase in heart rate. Thanks to the introduction of more modern methods of pre-operative care, to the great advancement of the science of anesthesia, and the entrance into this field of skilled anesthetists, most of the alarming and distressing reactions observed years ago have disappeared. Generally speaking, there was greater apprehension because of the anesthetic than there was of the surgical operation. At the present time it is believed that the properly administered anesthetic throws no additional burden on the heart. We are also of the opinion that when such aforementioned alarming and distressing reactions occur, the modern surgeon attributes them, not to the anesthetic but to the lack of skill of the anesthetist.

In patients with heart disease, irrespective of the type, before advising surgical intervention it is necessary for the internist to know more about the condition of the heart muscle than the type of heart lesion he has. The internist therefore wants to know if the crippled heart is able to function as a good working pump, how much of a load it is now carrying and how much of an increase it will be able to take without showing evidence of fatigue, how much reserve strength the heart has which will be available in the event there are extra demands for its use, and how such facts can be determined beforehand.

To secure such information, must we depend on physical examination, on various instruments of precision, or are we to use these only as confirmatory evidence of facts which have been elicited from a careful history as to what the patient can do without producing discomfort? In arriving at an intelligent decision concerning the reserve strength of the heart, it is necessary to inquire of the patient how much physical activity he can undergo without producing uncomfortable sensations.

Such questions are directed to determine the functional capacity of the left rather than of the right ventricle, since obviously in the majority of patients, except those with mitral stenosis, the left ventricle will be the first to show evi-

dence of weakness. We, therefore, inquire if the patient is able to walk several blocks or to climb several flights of stairs at a reasonable pace, or to walk up a hill, or run a short distance for a street car without producing difficult breathing. Is he able to hold his breath for 40 seconds without discomfort? Can he sleep on 1 pillow? Does he have paroxysmal attacks of dyspnea? If these simple measures are carried out, together with a careful physical examination and such laboratory procedures as are indicated and it is found that the patient is able to undergo the usual exercise tests without respiratory distress, we are reasonably certain that he can undergo a surgical operation without increased danger.

In judging of a patient's heart condition it is important to bear in mind that there is considerable difference between heart disease and heart failure. A patient may have evidence of heart disease yet his myocardium is capable of performing as much work as though his heart had no disease. There is a group of patients with heart disease who, in so far as it is possible to tell, present questions for solution which cannot always be answered with any degree of certainty. I refer to the group with such diseases as angina pectoris, syphilitic aortic insufficiency, aortic stenosis, and complete heart block. It is well known that patients with these disabilities are those who are subject to sudden death. This is a frequent occurrence and such catastrophes are impossible to foresee or foretell even after a most careful history, physical examination, and the use of other laboratory procedures. For this reason it is impossible to predict the effect of surgical operations on this class of patients. Whenever they are subjected to operation it should be understood that the risk is considerable, irrespective of the fact that the heart is functioning satisfactorily at the time.

Patients with irregular action of the heart, if this be due to an occasional premature beat, cause very little or no concern. If the premature beats occur frequently and especially if they are increased after exertion, this should cause us to bear in mind the possibility of developing ventricular tachycardia.

Patients with auricular fibrillation, in the absence of congestive heart failure, will stand operations remarkably well. If the heart is totally irregular but contracting at a fairly normal rate without a marked pulse deficit, there is little danger. In those patients with great irregularity and a marked pulse deficit, the operative hazard is considerably increased because they will give evidence of poor cardiac function. If permissible,

preliminary digitalization will markedly decrease the operative risk.

Hypertension occurring in patients with good cardiac function without symptoms of angina pectoris and with a normally acting heart, is no contra indication for surgery. The usual pre operative preparation of this class of patients for surgery is quite efficacious in preventing the former transient rise in blood pressure which in times past was so frequently seen.

Patients with mild congestive heart failure as determined by finding fine râles at the bases of both lungs, will undergo operations with less risk if there is ample time for bed rest and digitalis, with consequent improvement of cardiac function before operation. In those patients with marked congestive failure, as evidenced by orthopnea, edema, congestion at the bases of both lungs, and enlargement of the liver, only acute surgical emergencies should be considered. Any operation on this class of patients should be done with the idea in mind that whatever procedure was adopted would have to be predicated upon the theory that surgical intervention gave the patient a better chance of living than if he were denied such relief. Should no emergency exist, improvement of the heart action by enforced bed rest, limitation of fluids, promoting urinary excretion and the administration of digitalis and other helpful drugs is indicated.

The preliminary digitalization of patients with heart disease, who have good cardiac function before undergoing surgical operations in my opinion, serves no good purpose. A heart which functions normally is a good heart surgically and no drug administered before operation will improve this, however, it might be stated that sometimes in elderly patients with arteriosclerosis, small doses of digitalis given 2 or 3 days before operation may be definitely beneficial but in this group of patients one should always be careful not to produce digitalis intoxication. It is the experience of most cardiologists that the arteriosclerotic group is rather susceptible to digitalis effects.

Medical emergencies which may arise during the administration of an anesthetic or after the return of the patient to his room are such conditions as auricular fibrillation, paroxysmal auricular tachycardia and premature beats. As a rule these should give very little concern since they are usually transient in nature and tend to subside. Should they persist the use of vagal compression, digitalis or quinidine sulphate is quite helpful. Patients with ventricular tachycardia offer a most serious problem. This occurs usually

in those with rather marked arteriosclerosis and who have degenerative changes in the myocardium. Treatment with quinidine sulphate is advocated and should be tried. It has proved beneficial on numerous occasions.

It is not my intention to discuss peripheral vascular collapse. As all know, this is not due to heart disease but is a collapse of the vasomotor mechanism, producing shock. Treatment directed to the heart is of no use whatsoever but on the other hand is more than likely to do harm. Well known measures for increasing the blood volume such as immediate transfusion of blood, intravenous salt solution, etc., are the accepted forms of treatment.

#### POSTOPERATIVE CARE

After completion of the operation in those with heart disease attention should be directed to the prevention of conditions which might cause some embarrassment to the circulation. Chief among these are abdominal distention, postoperative vomiting, straining at stool and allowing patient to remain in a position too long. Simple measures are always available for meeting such situations without throwing any unusual strain on the heart.

I wish to direct attention to a phase of the post operative care of patients with heart disease and even those without this condition which I see so commonly abused, and that is the administration intravenously of large amounts of fluids, either as salt solution or salt solution containing rather high percentages of glucose, within a short space of time. The fact is lost sight of that attempts to increase rapidly the volume of the circulating blood throw an additional burden on the heart and that the administration of concentrated solutions of glucose temporarily disturbs the osmotic balance of the blood. Should it become necessary to give fluids intravenously to this group of patients it is a much better procedure to administer small amounts at frequent intervals than it is to introduce a large volume into the circulation in a short space of time. Furthermore it is better to furnish fluids subcutaneously rather than intravenously.

At times it is necessary to give solutions of glucose intravenously. These are best given in a 50 per cent solution in amounts of 30 to 40 cubic centimeters and repeated frequently rather than administering a large volume at any 1 time. One should bear in mind that it is a rather hazardous procedure to disturb the osmotic balance of the blood by the sudden introduction into the circulation of concentrated solutions in large volumes.

## SUMMARY

In this discussion it has been impossible to refer to all of the conditions which might arise in a given patient. However, I feel that if I have been successful in directing attention to the fact that the care of a patient affected with diabetes mellitus and the care of a patient suffering from

heart disease is not a problem which can be handled to the greatest good of the patient by any one individual, but that the existence of co-operative team-work between the anesthetist, the internist, and the surgeon will lead to the greatest number of successes and the fulfillment of a completed program, my effort will not have been in vain

# SURGICAL PROCEDURES IN THE PRESENCE OF DIABETES MELLITUS

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**A**NY discussion of the surgical procedures upon diabetic patients must presuppose an understanding of the surgical problem of the patient, of the effect of the metabolic disease upon the patient himself, and of its effect upon the course, treatment, and progress of the surgical complication. Successful management of this complication will demand careful co-ordination of this knowledge together with the proper selection of an anesthesia, an operative procedure planned and carried out with particular reference to the individual patient, and meticulous attention to the details of pre-operative and post-operative care. Even then let no one feel that the patient with diabetes can be operated upon with the same degree of safety as the patient without this disease.

## EFFECT OF DIABETES UPON THE PATIENT AND HIS SURGICAL DISEASE

In considering the surgical problem of a given patient we too often think in terms of the patient's metabolic disturbance, of its control during operation, and of the postoperative period. Too little do we consider the fundamental fact that this patient has had diabetes. Diabetes, controlled or uncontrolled over a period of years will result in varying degrees of arteriosclerosis. Too often have we seen a diabetic patient die suddenly from an unsuspected coronary thrombosis or be stricken with some other manifestation of cardiovascular disease not to be impressed with the significance of this complication. It is undoubtedly this arterio-sclerotic background which has prompted Dr. Joslin to say "A diabetic patient is as old as his age plus the duration of his diabetes."

Moreover, the patient is further handicapped by the effect of his metabolic disease upon his surgical complication and its management. Careless or inexperienced care of the diabetes may result in a continued glycosuria possibly coma, it will increase the incidence and severity of infection and may interfere with the healing of surgical wounds. Overzealous treatment on the other

hand, may result in insulin shock which, in the case of the older patient with cardiovascular disease, may be very serious.

Experience would suggest that in the controlled diabetic a clean surgical wound will heal in a manner comparable to a similar wound in a non-diabetic of similar age. On the other hand experience also tells us that the patient with diabetes is more susceptible to infection, that tissue necrosis is more frequently seen and is more extensive when present, that infection makes the diabetes more difficult to control and that the infection itself is more difficult to eradicate in the diabetic than in the non-diabetic patient. The past as well as the present of every diabetic patient facing a surgical procedure must be given careful consideration in any contemplated surgical undertaking.

## PRE-OPERATIVE AND POSTOPERATIVE CARE

Careful consideration is essential to the satisfactory management of surgical patients with diabetes mellitus. There must be a surgeon interested in the care of these patients to take responsibility for the surgical aspects of the problem. In addition there must be an internist of wide experience in the care of diabetic patients to assume charge of the pre-operative preparation and postoperative care of the medical aspects of the problem and also an experienced anesthetist to assure the selection and administration of the anesthetic indicated for this particular patient. This should not be interpreted to mean that the surgeon is devoid of responsibility in the preparation of the patient for operation for after all his experience in the specific surgical procedure contemplated should be available to the internist and the patient both in preparation for the operation and in the care of the patient after operation. In other words, close co-operation for a common end is essential for the best interest of the patient.

May I summarize in a few paragraphs what one might call the medical observations of a surgeon. For an operation of election the patient should go to the operating room well fed, his liver stocked with glycogen and free and with no more than a trace of sugar in the urine. These are important points.

2 An emergency operation may be done in the presence of acidosis if the urgency of the condition justifies the increased risk which this incurs. It must be recognized, however, that the presence of acidosis may well restrict the extent of the surgical procedure and the selection of an anesthetic, and puts a much greater burden upon the medical consultant.

3 It is unnecessary and dangerous to attempt to render the urine sugar-free within 3 days after operation. So far as I know there is no evidence that a moderate elevation of blood sugar to 180 milligrams per cent or the presence of a decreasing amount of sugar in the urine for 4 or 5 days after operation in any way interferes with the healing of a clean surgical wound.

4 Insulin dosage based on urine tests is simple and safe provided the doses are small, that the patient is emptying the bladder, and that hypoglycemia is guarded against by occasional blood sugar determinations as soon as the urine is sugar-free.

5 If intravenous glucose is given, it is dangerous and unnecessary to attempt to utilize all the glucose given by an estimated dose of insulin. It is even more dangerous to give insulin for the glucose which usually spills over in the urine after an intravenous injection. We have seen hypoglycemic reactions follow this procedure repeatedly. It is my belief that if intravenous glucose is to be given, it is safe to give insulin according to the urine passed just before the administration of the intravenous solution, and to disregard the glucose given intravenously and discard the first specimen of urine passed following the glucose injection. If in doubt, it is better to give glucose under the skin and to avoid its intravenous use.

6 Failure to recognize a marked increase in carbohydrate tolerance following the removal of an infected leg or drainage of a carbuncle or large abscess is a frequent source of hypoglycemic reaction.

#### SELECTION OF ANESTHESIA

Theoretically the ideal anesthetic should be one with little or no effect upon the diabetic state, it should not be toxic to the liver or kidneys, and should not be associated with anoxemia. From a practical point of view, however, the anesthetic for a given surgical procedure will depend upon (1) the surgical problem, (2) the age, duration and severity of the diabetes, and the general condition of the patient, (3) the experience and skill of the anesthetist, and (4) the experience of the medical man in the care of surgical diabetic patients. Regardless of other factors, the anesthetic selected must be one which will permit the surgeon to

TABLE I — OPERATIONS UPON PATIENTS WITH DIABETES MELLITUS AT THE NEW ENGLAND DEACONESS HOSPITAL

Region of operation	Major	Minor	Total	Deaths
Tongue, face, ear, and eye—carcinoma	2	4	6	0
Skin—carbuncles	71	0	71	4
Skin—abscess	0	100	100	8
Skin—other causes	3	14	17	0
Breast	10	4	14	0
Neck	6	2	8	0
Chest	3	0	3	0
Stomach and duodenum	5	0	5	2
Small intestine	2	0	2	0
Appendix	38	0	38	2
Large intestine	24	0	24	4
Rectum	12	19	31	1
Gall bladder and bile ducts	70	0	70	7
Other abdominal operations	16	1	17	3
Hernia	10	0	10	0
Circulatory system	0	25	25	1
Male genito-urinary system	1	0	1	0
Female genito-urinary system	25	2	27	2
Upper extremities	21	56	77	3
Lower extremities	657	73	730	65
Totals	976	300	1276	102*

\*This represents 8 per cent of the total number of operations performed.

complete the operation indicated in a minimum of time, with a minimum of trauma and a maximum of safety. Without going into detail, we may summarize a few of the more important facts from the literature and our own experience with the more commonly used anesthetics as follows. Ether causes hyperglycemia, acidosis, and is toxic to the liver.<sup>1</sup> Nevertheless, it is frequently our anesthetic of choice in operations in the lower abdomen.

Chloroform is too toxic to the liver, has all the disadvantages of ether, and we never use it.

Nitrous oxide and oxygen, ethylene oxygen, or cyclopropane and ether in conjunction with novocain block of the abdominal wall is our choice of an anesthesia for operations upon the gall bladder and stomach. If nitrous oxide and oxygen are used, great care must be taken to avoid cyanosis. Enough ether should be added to make respirations easy and permit good color.

<sup>1</sup>Coleman in his recent work finds avertin most toxic to the liver, and in order of decreasing toxicity anesthetics range as follows: nitrous oxide, oxygen and ether vapor, spinal, nitrous oxide and oxygen, local procaine (Surgery, 1938, 3: 87).

TABLE II—COMPARISON OF OPERATIVE AND NON OPERATIVE TREATMENT OF GANGRENE AND INFECTION 1923-1938

Operation	Gangrene				Infection			
	No. cases	Re-amputation at higher level	Deaths	Mortality per cent	No. cases	Re-amputation at higher level	Deaths	Mortality per cent
Incision and drainage	4	1	2	50	8	0	1	12.5
Amputation of 1 or more toes	28	5	2	3.6	54	5	0	0
Lower leg amputation	2	0	0	0	2	0	0	0
Gluteal amputation	22	6	4	33.3	7	5	1	14.3
Critch Spokes amputation	3	0	0	0	1	0	1	100
Thigh amputation	68	0	24	34.3	3	0	0	0
Total operations	147	12	20	23.6	75	5	3	4
No operation	259		8	3.1	235		4	1.7

Evipal is excellent for short operations when relaxation is not required, especially in incision and drainage of carbuncles when the electro-surgical knife is used. It must be used with care. The dosage varies greatly. We have seen the maximum dose of 20 cubic centimeters inadequate for the drainage of a septic finger in a young diabetic woman, frail but in good condition, whereas in the next patient, a heavy man of 55, a large carbuncle was incised and drained with 4 cubic centimeters of the solution.

Procaine regionally and locally has little effect on the diabetes, liver or kidneys, and is used extensively alone or in conjunction with gas anesthesia as mentioned above. It is never used for the amputation of a digit or for incision of a carbuncle.

Spinal procaine is used almost exclusively for operations upon the lower extremities for most inguinal hernias and for minor procedures around the rectum and perineum. It is frequently used in operations upon the lower abdomen, especially in women without extensive cardiovascular disease, rarely for operations on the upper abdomen. Fifty to 75 milligrams are adequate for an operation on the lower extremities. The level of the anesthesia rarely reaches above the level of the iliac crest and except as noted below, we have never recognized it as directly contributing to a mortality. In many of our patients we doubt that any other anesthetic could have been used with equal safety. We do not believe that relaxation of the sphincter and secondary to spinal anesthesia is an important cause of gas bacillus infection in an amputation stump.

Avertin we believe to be a dangerous anesthetic in the presence of cardiovascular renal disease, and we never use it in these patients.

#### PRE OPERATIVE MEDICATION

Diabetic patients are in general much more susceptible to drugs than are non-diabetic patients of comparable size and age. Moreover, diabetic patients as a group are accustomed to physical and mental insults and are much more tolerant of operations than are most people. In our earlier experiences I was uncertain lest in 2 instances heavy pre-operative medication in preparation for operations had contributed to ward fatal outcomes. Our pre-operative medication is therefore simple. One and one half grains of nembutal,  $1\frac{1}{2}$  grains of phenobarbital or 3 grains of sodium amytal is frequently given to the more apprehensive patients the night before operation. One-eighth to one-fourth grain of morphine sulphate with one one hundred and fiftieth grain of atropine, is used 30 minutes before an inhalation anesthetic. The older and more debilitated patients are frequently given no pre-operative medication. None of our patients operated upon for gangrene are given pre-operative sedation of any kind and in many instances I have seen these patients sleep through operations.

#### SPECIFIC OPERATIONS

In Table I are listed the operations performed by my associate Dr. Theodore C. Pratt and myself for the 10 year period preceding January 1, 1938. A glance at the table shows that it is not a true cross section of all the surgical problems these patients present. Operations in the various specialties have not been done by us and practically all operations upon the thyroid gland in

A total of 124 operations have been done on the lower extremities of 825 patients since 1923. The first and only post-operative gas bacillus infection of a stump occurred in 1934.

TABLE III — OPERATIONS FOR GANGRENE  
1923-1938

Operations	No cases	Deaths	Mortality per cent
Amputation of 1 or more toes	53	4	7.5
Amputation of toe, then major amputation	35	4	11.4
Incision and drainage only	8	0	0
Incision and drainage, then major amputation	2	2	100
Guillotine amputation	33	14	42.4
Lower leg amputation	36	1	2.8
Gritti-Stokes amputation	80	11	13.8
Thigh amputation	266	31	11.7
Toe amputations	88	8	9.1
Major amputations	452	59	13.1

patients with diabetes at the Deaconess Hospital have been done by Dr F H Lahey and his associates

Major operations include those in which the abdominal or thoracic cavity had been opened, hernias of all types, dissection of the neck, amputation of a digit or extremity, incision and drainage of a carbuncle, open reduction of a fracture, amputation of a breast with or without dissection of the axilla, embolectomy, plastic operations upon the vagina, and ligation of the femoral or popliteal artery

Minor operations include a variety of lesser procedures such as skin grafts, local excision of superficial benign or malignant lesions, the evulsion of nails, closed reduction of fractures, removal of foreign bodies, drainage of superficial abscesses, high ligation and injection of the saphenous vein. Transfusions and a large number of smaller surgical procedures carried on in the wards are not included. *Multiple operations for the same condition are listed as 1 operation.* Thus a 2 stage resection of the colon or multiple operations upon a lower extremity for a single lesion are listed as 1 operation. As in all our statistics, any patient who, following a surgical operation, dies during that hospital admission is listed as a

TABLE IV — HEALING IN 100 CONSECUTIVE  
SUPRACONDYLAR AMPUTATIONS BEGIN-  
NING JANUARY, 1935

	Number
Infection of stump	
Major	2
Minor	5
Deaths	
Stump clean	12
Stump infected	2
Mortality—per cent	14

TABLE V — OPERATIONS FOR INFECTION  
1923-1938

Operation	No cases	Deaths	Mortality per cent
Amputation of 1 or more toes	186	2	1.1
Amputation of toe, then major amputation	18	2	11.1
Incision and drainage only	40	4	10
Incision and drainage, then major amputation	1	0	0
Guillotine amputation	12	5	41.7
Lower leg amputation	10	0	0
Gritti-Stokes	6	1	16.7
Thigh amputation	18	2	11.1
Toe amputations	204	4	2
Major amputations	65	8	12.3

surgical death regardless of the actual cause of death and regardless of whether or not he has entirely recovered from the condition for which he was operated upon

*Gangrene of the lower extremities.* Of patients who have entered the New England Deaconess Hospital during the past 3 years for treatment of some phase of arterial deficiency, 48 per cent have left the hospital without operation (Table II). The average age of those patients undergoing operation is 65 years. The mortality for all major amputations upon patients with gangrene from 1923 to 1938 has been 13.1 per cent (Table III). Ninety per cent of these patients who have come to operation have had a major amputation

The many factors entering into the selection of the level at which amputation should be done cannot be repeated here. If, however, one gives careful consideration to the various problems involved, the selection of the level of amputation is not difficult. It is our belief that *guillotine amputation*, preferably through the upper third of the lower leg, is indicated (1) for extensive infection in the presence of severe diabetes, (2) in patients with septicemia secondary to gangrene and infection of the limb, and (3) in debilitated patients whose general condition is so poor that primary healing is not anticipated. *Amputation of a toe* is dangerous in the presence of unlocalized infection and will rarely if ever be successful if pain is severe. It should only rarely be attempted in a pulseless foot if infection has involved the deeper structures of the foot. *Amputation of the lower leg* should never be considered in any patient whose general condition precludes the use of an artificial limb. It should never be done in the absence of pulsation in the popliteal artery, and it should



TABLE VI—OPERATIONS FOR APPENDICITIS JANUARY 1924 TO JUNE 1934

Operation	Without drainage		With drainage		Total cases	Total deaths	Mortality per cent
	Cases	Deaths	Cases	Deaths			
Appendectomy	37	0	6	1	43	1	2.3
Drainage of abscess with or without spreading peritonitis	0	0	6	2	6	2	33.3
Totals	37	0	12	3	49	3	6.1

never be done in the presence of a lymphangitis above the level of the ankle. We have elected amputation through the lower leg in only 7 per cent of our patients with gangrene. *Griffith Stokes amputation* gives an excellent end bearing stump, but we are now convinced that in the patient with diabetes it should be used only in selected cases and then only when the surgeon has had considerable experience with the operation. A *supra condylar amputation*, using a circular incision without a tourniquet and with careful closure of the wound without drainage, is the safest amputation we know. In 100 consecutive amputations of this type done at the New England Deaconess Hospital the mortality has been 14 per cent (Table IV). First intention<sup>1</sup> healing has occurred in 93 per cent of the cases, and in only 2 cases was there deep infection of the stump. We have not used the operation of Callander because of the universal satisfaction from the simpler supra condylar amputations mentioned above.

*Infection of the lower extremities.* Probably the most important lesions we see involving the lower extremities are those in the feet of diabetic patients with adequate circulation as evidenced by (1) good pulsation in the dorsalis pedis artery, or (2) no primary pulsation but excellent collateral circulation as evidenced by a foot of normal appearance, warm and well nourished. Gangrene may be present but is secondary to infection and local thrombosis, rather than due to a primary arterial occlusion. It is of interest that in this

Stump completely healed & sutures out in 12 days

group of patients a marked degree of hypesthesia at times actual anesthesia is frequently noted. Only recently we removed the great toe of such a patient in the ward without anesthesia because of the extensive infection which was present and we have frequently incised and drained infections of the feet in this group of people without anesthesia of any kind. It is in this group of cases that osteomyelitis of a phalanx is so common. Amputation of a digit for osteomyelitis of an interphalangeal joint on a foot with good pulsation in the dorsalis pedis artery is one of the safest and most satisfactory procedures we know (Table V).

We have successfully removed one or more toes in 186 patients, with a mortality of 1.1 per cent. In 18 instances a higher amputation was necessary, and in these unsuccessful cases the infection had already extended to the deeper structures of the foot. It is also of importance that in this group of cases removal of one toe, particularly the great toe, is frequently followed by the development of a callus and then ulceration in the tip of the adjacent toe (Fig. 1). It is in cases of this type that amputation of all the remaining toes for prophylactic reasons may be indicated (Fig. 2). Amputation through the lower leg is not infrequently advised in this group of patients in preference to long continued and extensive infection involving the deeper structures of the foot.

Amputation of a digit for osteomyelitis of an interphalangeal joint is done with a racquet incision through the proximal phalanx. In cases in which the infection has involved the deeper

TABLE VII—FATAL CASES AFTER OPERATION UPON THE GALL BLADDER

Case no.	Sex	Age	Disease	Anesthesia	Operation	Cause of death
3469	M	55	Chronic cholecystitis with cholelithiasis	Gas ether	Cholecystectomy	Streptococcus sepsis of abdominal wall
3490	F	65	Cholecystitis with abscess & duodenal fistula	Spinal anesthetic	Cholecystectomy closure of duodenal fistula	Double fistula bronch pneumonia
3040	F	33	Hydrops of gall bladder	Spinal novocain	Cholecystectomy	Cerebral hemorrhage
1999	M	55	Empyema with gangrene and subcutaneous perforation	Novocain & nitrous oxide	Partial removal of gall bladder	Peritonitis

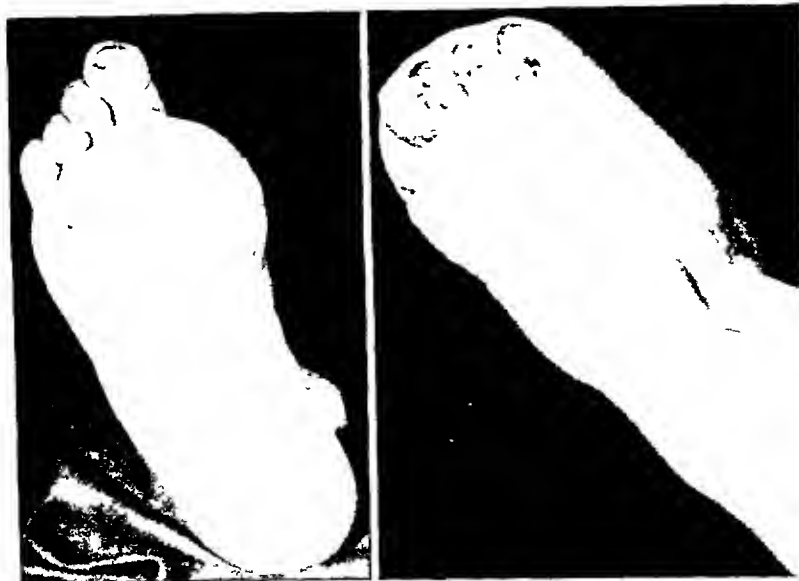


Fig 1, at left Ulceration at the tip of the second toe from pressure following amputation of the great toe

Fig 2 Same as Figure 1, after amputation of remaining toes

structures of the foot, the position and character of the incisions used for drainage are of extreme importance (Figs 3, 4, 5). In most instances adequate drainage will require the removal of one or more toes. In general, incisions should be made too long rather than too short. They should be so placed that, with the foot in the normal resting position, the lower part of the incision will represent the most dependent part of the wound. If infection involves a metatarsophalangeal joint, all of the head of the involved metatarsal should be removed (Fig 6). For drainage of the great toe, fourth, or fifth toes, lateral incisions are used, and in the case of the fourth toe the head of the fifth as well as of the fourth toe must be removed so that the wound is one wide, open cavity (Fig 6).

For removal of the middle toe and at times the second toe, a wedge is removed with the incision on the plantar surface of the foot being extended sufficiently to give adequate dependent drainage (Fig 7). Whenever the head of a metatarsal is excised, all sesamoid bones or cartilaginous tissue should be removed.

We do not use any complicated treatment of the cut plantar tendon. A clean, sharp knife is used. Great care is taken not to pull on the tendon and let it snap back into its sheath. Rather the tendon is cut so as to allow a few millimeters of tissue to project beyond the cut end of the sheath. In an

open, infected wound a piece of dry gauze is immediately placed over the cut tendon. A second small piece of dry gauze is then packed loosely over this. After 24 hours the packing is moistened with Dakin's solution morning and evening and is removed in 3 or 4 days. Thereafter the packs are changed daily and are kept moist with Dakin's solution. In larger wounds one or more Dakin's tubes are inserted and 5 cubic centimeters of solution instilled in each tube every 2 hours. In clean wounds to be closed, the tendon is cut with a clean, sharp knife. No other method of treatment is needed.

*Infections of the hand* In the splendid symposium on diabetic surgery before the forty-fifth Congrès français de Chirurgie, Jeanneney (5) gave an excellent résumé of the difficulty experienced in controlling these infections and offered definite suggestions as to their management. Bothe refers to the large amount of necrosis and the difficulty in controlling palmar abscesses. There is otherwise very little mention of this serious and important problem in the literature. Dr. Walter Garrey and myself carefully studied the 70 patients admitted to the New England Deaconess and Massachusetts General Hospitals between January 1, 1933, and January 1, 1937. Seven and one-tenth per cent of these patients died, and another 7 per cent survived an amputation through or above the forearm. Thirty per

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	Cases	Deaths	Cases	Deaths			
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*Stump completely healed and sutures out in 22 days*

group of patients a marked degree of hypesthesia at times actual anesthesia, is frequently noted. Only recently we removed the great toe of such a patient in the ward without anesthesia because of the extensive infection which was present and we have frequently incised and drained infections of the feet in this group of people without anesthesia of any kind. It is in this group of cases that osteomyelitis of a phalanx is so common. Amputation of a digit for osteomyelitis of an interphalangeal joint on a foot with good pulsation in the dorsalis pedis artery is one of the safest and most satisfactory procedures we know (Table V).

We have successfully removed one or more toes in 156 patients, with a mortality of 1.1 per cent. In 18 instances a higher amputation was necessary, and in these unsuccessful cases the infection had already extended to the deeper structures of the foot. It is also of importance that in this group of cases removal of one toe particularly the great toe, is frequently followed by the development of a callus and then ulceration in the tip of the adjacent toe (Fig. 1). It is in cases of this type that amputation of all the remaining toes for prophylactic reasons may be indicated (Fig. 2). Amputation through the lower leg is not infrequently advised in this group of patients in preference to long continued and extensive infection involving the deeper structures of the foot.

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Case no.	Sex	Age	Diagnosis	Anesthesia	Operation	Cause of death
3469	M	55	Chronic cholecystitis choledithiasis	Gas ether	Cholecystectomy	Streptococcus cellulitis abd m al wall
3490	F	65	Cholecystitis with abscess and duodenal fistula	Spinal novocaine	Cholecystectomy closure of duodenal fistula	Peridoneal fistula bronchopneumonia
3080	F	53	Hydrops of gall bladder	Spinal novocaine	Cholecystectomy	EC cerebral hemorrhage
7009	M	55	Empyema with gangrene of the cutaneous perforator	Diethyl ether and nitrous oxide	Partial removal of the gall bladder	Peritonitis

TABLE IX — MAJOR OPERATIONS UPON THE GASTRO-INTESTINAL TRACT

January, 1928 to June, 1938

Operation	No cases	Deaths	Mortality per cent
Stomach and duodenum			
Resection of gastrojejunocolic fistula	1	0	0
Closure of perforation	1	1	100
Judd pyloroplasty	2	1	50
Gastrojejunostomy	1	0	0
Gastrostomy	1	0	0
Exploration—biopsy	2	0	0
Small intestine			
Resection and anastomosis	1	0	0
Entero enterostomy	1	0	0
Lysis of adhesions for acute obstruction	2	0	0
Colon			
Resection with anastomosis	10	2	20
Excision with colostomy	3	1	33.3
Entero enterostomy	2	1	50
Closure of perforation	1	0	0
Drainage of diverticulitis	2	1	50
Closure of sigmoidovesicle fistula	1	0	0
Closure of colostomy	1	0	0
Colostomy	1	0	0
Rectum			
Combined abdominoperineal, 1 stage	1	1	100
Combined abdominoperineal, 2 stages	1	0	0
Colostomy and posterior excision	3	1	33.3
Colostomy	4	2	50
Totals	42	11	26.2

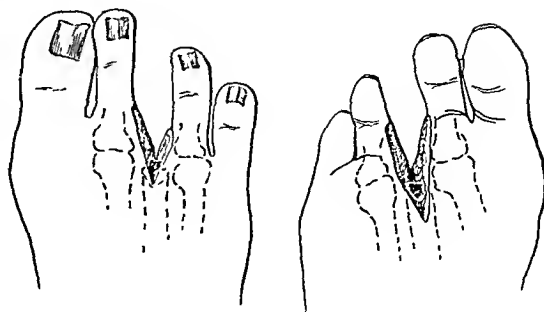


Fig 5 Incision used for removal of the second or third toe proximal to the head of the metatarsophalangeal joint

Protection of the surrounding skin is important. It is washed daily with tincture of green soap and water, wiped off with alcohol, and painted with compound tincture of benzoin. Even with this precaution small pustules may develop. Necrotic tissue is removed as it separates, but great care is taken not to subject the patient to the painful removal of tissue before separation is complete. The large carbuncle always begins as a small one, and early adequate treatment should prevent the development of a fatal lesion.

#### ABDOMINAL SURGERY

*Abdominal symptoms due to acidosis* Most of the more recent articles on diabetic surgery give ample space to the syndrome of pain, vomiting, spasm, fever, and leucocytosis, not infrequently associated with acidosis and without any demonstrable organic lesion within the abdomen. We have seen a white count in such a condition as high as 80,000. The mere fact that a diagnosis of perforated ulcer, perforated appendix, or acute pancreatitis is frequently made is evidence that the pain may be severe and the findings diffuse rather than localized. Accurate differentiation can usually be made by a careful history obtained from a member of the family or the patient, and by the generalization rather than the localization of findings. In most instances the diagnosis can be confirmed following a few hours of insulin treatment, since the pain and abdominal signs clear very quickly in the absence of a surgical lesion and usually become more definite in its presence. Although the occasion has never presented itself, we would have no hesitancy in making a small incision under novocain anesthesia did we feel that the findings were such as to make delay unsafe.

*Appendicitis* With an increasing number of children maturing and entering adult life, there will be an increasing number of cases of appendi-

betic patient with a spreading infection involving the deeper structures of the hand.

*Carbuncles* It is our belief that carbuncles are surgical infections and as such are best treated by adequate incision at the proper time. Four, or 5 per cent, of the 71 patients we have operated upon for this infection in the 10 year period have died. All deaths have been in patients with large lesions, 10 centimeters or more in diameter. Careful treatment of the patient's general condition and his diabetes, local heat and x-ray to hasten localization, then crucial incision with undermining of the flaps, using the electrosurgical knife is, we believe, the procedure of choice. The wound is packed with dry gauze. This packing is removed as it loosens, usually in 3 or 4 days. Thereafter the wound is repacked loosely each day with gauze saturated with Dakin's solution or azochloramid.<sup>1</sup>

<sup>1</sup>Azochloramid, 1:3300 in normal saline solution is used 3 times daily, or the oily solution 1:500 in triacetin is used once daily.



Fig. 3 Incision used for drainage of infection involving the subcutaneous tissues at the base of the toes. This may be combined with removal of one or more toes or connected with drainage on the dorsum of the foot if necessary.

cent of these patients lost all or a part of one or more fingers. Certain facts seemed to contribute toward these poor results: (1) late hospitalization and inadequate incisions, usually after ambulatory treatment in spite of the known difficulty in controlling infection in patients with diabetes through small inadequate incisions, and (2) the presence of a mixed infection as noted in most cases when finally hospitalized.

Our experience in the management of these cases particularly of the tendon sheath infections, is too limited to warrant any dogmatic statements at this time. We believe we are justified however in advocating that any patient who is seen with an infection of the hand and diabetes should be immediately hospitalized; that operation if indicated should be in a bloodless field and painstakingly done under general anesthesia and that incisions should be adequate so that the infected area is completely opened. For the simpler paronychia we advocate early removal of the entire nail. For felons we advocate the complete fish mouth incision and for infections of the tendon sheath we suggest that the sheath be completely opened throughout its entire length. In case of extension to the radial or ulnar bursa or

TABLE VIII—OPERATIONS UPON THE BILIARY TRACT

January 1924 to June 1933

Operation	Cases	Survival	Death	Mortality per cent
Cholecystectomy	39	33	3	7.7
Cholecystostomy	0	0	1	100
Cholecystectomy and cholecystostomy	10	9	0	0
Cholecystectomy	2	2	0	0
	60	55	4	6.7
Cholecystectomy (if resection of pancreas)	8		1	12.5
Cholecystectomy (no resection of pancreas)	1		0	0
Total	70		5	7.1

\*In 7 cases stone was present in the duct.

both we believe that the crucial ligament should be divided. If there is beginning necrosis of the tendon at the time of operation it is our present belief that the tendon can best be removed at the primary operation. Early amputation of a finger for involvement of the bone or joint may greatly shorten the convalescence, but we believe that amputation of the hand should be undertaken only as a life saving procedure or when destruction beyond hope of usefulness has taken place and this latter is rare indeed. In our own experience there is no group of patients in which the judgment and experience of the surgeon will be so thoroughly tried as in the management of a dia-



Fig. 4 Incision for amputation of the great toe proximal to the head of the first metatarsophalangeal joint showing the line of extension of the incision to drain the subfascial area of the medial half of the foot. A similar type of incision is used for the fifth toe.

TABLE IX—MAJOR OPERATIONS UPON  
THE GASTRO-INTESTINAL TRACT

January, 1928 to June, 1938

Operation	No cases	Deaths	Mortality per cent
Stomach and duodenum			
Resection of gastrojejunocolic fistula	1	0	0
Closure of perforation	1	1	100
Judd pyloroplasty	2	1	50
Gastrojejunostomy	1	0	0
Gastrostomy	1	0	0
Exploration—biopsy	2	0	0
Small intestine			
Resection and anastomosis	1	0	0
Entero enterostomy	1	0	0
Lysis of adhesions for acute obstruction	2	0	0
Colon			
Resection with anastomosis	10	2	20
Excision with colostomy	3	1	33.3
Entero enterostomy	2	1	50
Closure of perforation	1	0	0
Drainage of diverticulitis	2	1	50
Closure of sigmoidovesicle fistula	1	0	0
Closure of colostomy	1	0	0
Colostomy	1	0	0
Rectum			
Combined abdominoperineal, 1 stage	1	1	100
Combined abdominoperineal, 2 stages	1	0	0
Colostomy and posterior excision	3	1	33.3
Colostomy	4	2	50
Totals	42	11	26.2

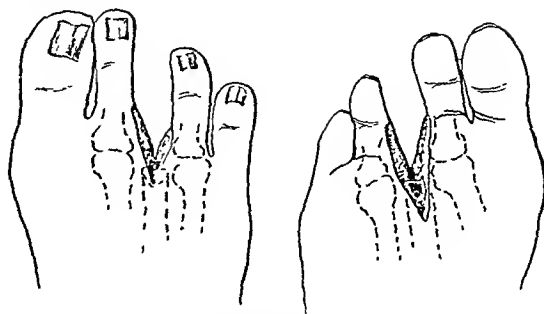


Fig 5 Incision used for removal of the second or third toe proximal to the head of the metatarsophalangeal joint

Protection of the surrounding skin is important. It is washed daily with tincture of green soap and water, wiped off with alcohol, and painted with compound tincture of benzoin. Even with this precaution small pustules may develop. Necrotic tissue is removed as it separates, but great care is taken not to subject the patient to the painful removal of tissue before separation is complete. The large carbuncle always begins as a small one, and early adequate treatment should prevent the development of a fatal lesion.

#### ABDOMINAL SURGERY

*Abdominal symptoms due to acidosis.* Most of the more recent articles on diabetic surgery give ample space to the syndrome of pain, vomiting, spasm, fever, and leucocytosis, not infrequently associated with acidosis and without any demonstrable organic lesion within the abdomen. We have seen a white count in such a condition as high as 80,000. The mere fact that a diagnosis of perforated ulcer, perforated appendix, or acute pancreatitis is frequently made is evidence that the pain may be severe and the findings diffuse rather than localized. Accurate differentiation can usually be made by a careful history obtained from a member of the family or the patient, and by the generalization rather than the localization of findings. In most instances the diagnosis can be confirmed following a few hours of insulin treatment, since the pain and abdominal signs clear very quickly in the absence of a surgical lesion and usually become more definite in its presence. Although the occasion has never presented itself, we would have no hesitancy in making a small incision under novocain anesthesia did we feel that the findings were such as to make delay unsafe.

*Appendicitis.* With an increasing number of children maturing and entering adult life, there will be an increasing number of cases of appendi-

betic patient with a spreading infection involving the deeper structures of the hand.

*Carbuncles.* It is our belief that carbuncles are surgical infections and as such are best treated by adequate incision at the proper time. Four, or 5 per cent, of the 71 patients we have operated upon for this infection in the 10 year period have died. All deaths have been in patients with large lesions, 10 centimeters or more in diameter. Careful treatment of the patient's general condition and his diabetes, local heat and x-ray to hasten localization, then crucial incision with undermining of the flaps, using the electrosurgical knife is, we believe, the procedure of choice. The wound is packed with dry gauze. This packing is removed as it loosens, usually in 3 or 4 days. Thereafter the wound is repacked loosely each day with gauze saturated with Dakin's solution or azochloramid.<sup>1</sup>

<sup>1</sup>Azochloramid 1:3,000 in normal saline solution is used 3 times daily, or the only solution 1:5,000 in triacetin is used once daily.



Fig. 3. Incision used for drainage of infection involving the subcutaneous tissues at the base of the toes. This may be combined with removal of one or more toes or connected with drainage on the dorsum of the foot if necessary.

cent of these patients lost all or a part of one or more fingers. Certain facts seemed to contribute toward these poor results: (1) late hospitalization and inadequate incisions, usually after ambulatory treatment in spite of the known difficulty in controlling infection in patients with diabetes through small inadequate incisions; and (2) the presence of a mixed infection as noted in most cases when finally hospitalized.

Our experience in the management of these cases, particularly of the tendon sheath infections, is too limited to warrant any dogmatic statements at this time. We believe we are justified however in advocating that any patient who is seen with an infection of the hand and diabetes should be immediately hospitalized; that operation if indicated should be in a bloodless field and painstakingly done under general anesthesia and that incisions should be adequate so that the infected area is completely opened. For the simpler paronychia we advocate early removal of the entire nail. For felons we advocate the complete fish mouth incision, and for infections of the tendon sheath we suggest that the sheath be completely opened throughout its entire length. In case of extension to the radial or ulnar bursa or

TABLE VIII.—OPERATIONS UPON THE BILIARY TRACT

January 1924 to June 1938

Operation	Cases	Stones	Deaths	Mortality per cent
Cholecystectomy	50	33	3	7.7
Cholecystostomy	0	0	1	100
Cholecystectomy and choledochotomy	10	9	0	0
Choledochostomy	2	2	0	0
	60	5	4	6.7
Cholecystectomy and choledochotomy (case of pancreas)	3		1	33.3
Choledochostomy and choledochotomy (case of pancreas)	2		0	0
Total	70		5	7.1

17 cases stones were present in the duct

both we believe that the crucial ligament should be divided. If there is beginning necrosis of the tendon at the time of operation it is our present belief that the tendon can best be removed at the primary operation. Early amputation of a finger for involvement of the bone or joint may greatly shorten the convalescence, but we believe that amputation of the hand should be undertaken only as a life saving procedure or when destruction beyond hope of usefulness has taken place and this latter is rare indeed. In our own experience there is no group of patients in which the judgment and experience of the surgeon will be so thoroughly tried as in the management of a dia-



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Closure of perforation	1	1	100
Judd pyloroplasty	2	1	50
Gastrojejunostomy	1	0	0
Gastrostomy	1	0	0
Exploration—biopsy	2	0	0
Small intestine			
Resection and anastomosis	1	0	0
Entero enterostomy	1	0	0
Lysis of adhesions for acute obstruction	2	0	0
Colon			
Resection with anastomosis	10	2	20
Excision with colostomy	3	1	33 3
Entero enterostomy	2	1	50
Closure of perforation	1	0	0
Drainage of diverticulitis	2	1	50
Closure of sigmoidovesicle fistula	1	0	0
Closure of colostomy	1	0	0
Colostomy	1	0	0
Rectum			
Combined abdominoperineal, 1 stage	1	1	100
Combined abdominoperineal, 2 stages	1	0	0
Colostomy and posterior excision	3	1	33 3
Colostomy	4	2	50
Totals	42	11	26 2

betic patient with a spreading infection involving the deeper structures of the hand

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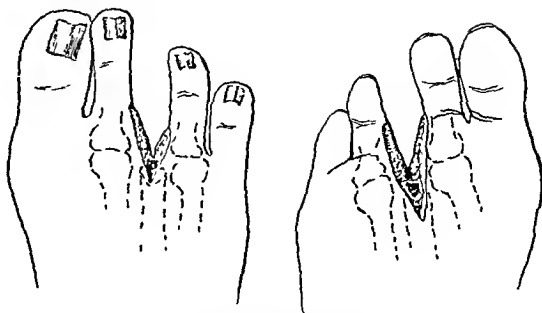


Fig 5 Incision used for removal of the second or third toe proximal to the head of the metatarsophalangeal joint

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TABLE VIII—OPERATIONS UPON THE BILIARY TRACT

January 1924 to June 1938

Operation	Cases	Survivors	Deaths	Mortality per cent
Cholecystectomy	30	23	3	10
Cholecystostomy	0	0	1	100
Cholecystectomy and cholecystostomy	10	9	0	0
Cholecystostomy	2	2	0	0
	60	34	4	6.7
Cholecystectomy (if carcinoma of pancreas)	8		5	62.5
Cholecystectomy (for cancer of pancreas)	2		0	0
Total	70		5	7.1

\*In 7 cases stone was present in the duct.

both we believe that the crucial ligament should be divided. If there is beginning necrosis of the tendon at the time of operation, it is our present belief that the tendon can best be removed at the primary operation. Early amputation of a finger for involvement of the bone or joint may greatly shorten the convalescence, but we believe that amputation of the hand should be undertaken only as a life saving procedure or when destruction beyond hope of usefulness has taken place and this latter is rare indeed. In our own experience there is no group of patients in which the judgment and experience of the surgeon will be so thoroughly tried as in the management of a dia-



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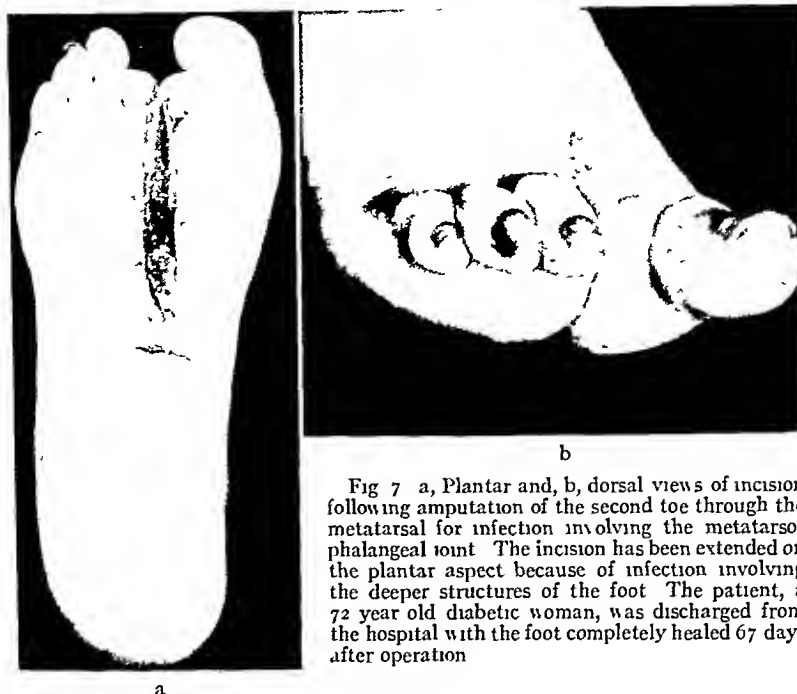


Fig 7 a, Plantar and, b, dorsal views of incision following amputation of the second toe through the metatarsal for infection involving the metatarsophalangeal joint. The incision has been extended on the plantar aspect because of infection involving the deeper structures of the foot. The patient, a 72 year old diabetic woman, was discharged from the hospital with the foot completely healed 67 days after operation.

cellulitis of the abdominal wall, and Case No 3080, a woman of 53 supposedly in good condition for a diabetic of her age, died in a coma not of diabetic origin and not too satisfactorily explained, a third patient recently operated upon also had an unlooked for reaction, characterized by a semi-conscious state and other symptoms at first thought to be due possibly to cerebral hemorrhage, but this patient, after a somewhat delayed convalescence, recovered satisfactorily with no evidence of a cerebral accident. It is these experiences which make me feel that I cannot operate upon the diabetic patient with gall stones without accepting a slightly higher mortality than in non-diabetic patients of comparable age and with comparable pathology (Table VIII). It is also these experiences which make me feel that the indications for operation in this group should be clear-cut.

Our experience with acute cholecystitis in patients with diabetes is limited. This experience suggests, however, that the so called acute gall bladder in a patient with diabetes will not subside with the same frequency that it will in the non-diabetic patient. We have seen 5 such patients and in only 1 instance did the acute process subside so that a procedure of election could be done. Others progressed and operation had to be undertaken during the presence of an acute inflamma-

tory process. It is now our feeling that if a patient is admitted with an acute cholecystitis, we should probably be inclined toward operation as soon as the diabetic state is under reasonable control.

During the past 10 years we have done 10 anastomoses between the stomach or duodenum and the biliary system (Table VIII). It is our impression that this procedure can be carried out with a mortality not materially greater than that in non-diabetic patients. Almost without exception these operations are done under novocain anesthesia. A minimum of exploration is done and the gall bladder or, in its absence, the common duct is anastomosed to the stomach or duodenum. A simple type of anastomosis such as is commonly used in gastro-intestinal work has proved adequate. In none of these cases has there been leakage, and we see no indication for the use of a foreign body such as a button or rubber tube.

*Operations on the gastro-intestinal tract.* That extensive operations on the gastro-intestinal tract may be carried out in patients with long-standing diabetes was well shown by a recent patient seen and operated upon by us at the request of Dr Joslin.

CASE No 5963. A man of 57 with a diabetes of 15 years' duration entered the George F. Baker Clinic on March 20,



Fig 6 a Roentgenogram showing a portion of the head of the fourth metatarsal inadvertently left following amputation of the fourth and fifth toes for osteomyelitis at another hospital b wound through which the head of the fourth metatarsal was completely removed and the fifth metatarsal shortened c roentgenogram following second operation showing satisfactory treatment of the metatarsals

citis among patients with diabetes. Moreover the diagnosis of appendicitis in these children is somewhat more difficult to make than in a non diabetic patient, and failure to recognize the presence of the disease may result more seriously. It is, therefore, a problem of increasing importance particularly since it would seem reasonable to suppose that an inflamed appendix which in a non diabetic child might well subside, might in a diabetic patient progress to perforation and peritonitis. We have seen a number of diabetic children entering the hospital for attacks of abdominal pain in which we were unable to make a diagnosis of appendicitis and at the same time the pain and symptoms were not associated with acidosis or with any evidence of urinary tract infection. We have operated upon at least 3 of these patients who have had previous attacks which we have seen them through and in whom we were unable to make a diagnosis primarily because of the absence of demonstrable localized tenderness. We deliberately operated upon each of these 3 children after the acute symptoms had subsided but before any inflammatory process of the appendix would have had time to disappear completely. In none of these 3 children did we find any evidence of pathology in the appendix, the regional glands or the lower 3 feet of ileum. We nevertheless feel that it is safer to remove a normal appendix in a diabetic child having recurring attacks of pain not otherwise explained than it is to run the risk of overlooking a mild appendicitis which at a later date and under less favorable circumstances may become acute and progressive.

In the child with diabetes which is controlled and has been controlled it would seem as though operation under proper conditions could be done with a mortality little if any higher than that in a non diabetic patient (Table VI). Early hospitalization and early operation for signs and symptoms suggestive of appendicitis is, we believe even more clearly indicated in the patient with diabetes than in the patient without it.

*Operations upon the biliary tract.* We do not believe in operation upon the so called stoneless gall bladder with indefinite digestive symptoms. We do advise operation upon a diabetic patient with digestive symptoms referable to gall stone demonstrated by x ray or because of recurrent attacks of pain characteristic of or consistent with that due to gall stones when associated with roentgenological evidence of cholelithiasis. We believe that the finding of stones even in the presence of very few symptoms is an indication for operation in a diabetic patient in otherwise good condition.

We believe that the risk of biliary tract disease as well as of biliary tract surgery is greater in the diabetic than in the non diabetic patient. Some of the patients operated upon in this group were extremely poor risks in which a mortality even in a non diabetic patient might have been accepted as a definite possibility. On the other hand a study of the fatal case shows at least 2 instances in which a fatal outcome was not anticipated and in our judgment should not have occurred (Table VII). Case No. 3469 died after an operation of infection on a man of 55 years of age of a streptococcus.

# FACTORS DETERMINING SELECTION AND ADMINISTRATION OF ANESTHETICS

WESLEY BOURNE, M D , F R C P , Montreal, Canada

**I**N ANESTHESIA it is axiomatic that the drugs employed be chosen to suit the general condition as well as the surgical requirements of a given individual. This is equally true concerning the methods of their administration. Both become extremely important if the patient suffers some definite additional disability. It is well known that anesthetics are apt to disturb metabolism and to depress function. If these are already interfered with, the selection of the materials used and the modes by which they are given must be considered with the greatest care. While the desired and beneficial actions of anesthetics cannot be forgotten, the harmful effects may turn out to be manifold, indeed, all too often multiform, like the *wretchedness of earth*. Let us review a few of these ill-effects, those on the blood, the liver, and the kidneys, and let us remember, at this time, that the disturbances which take place in these parts do so concurrently and in an interdependent manner with the many other upsets in the rest of the organism. These disturbances are as various as the hues of the rainbow, as distinct, too, yet they are as intimately blended

## EFFECTS OF ANESTHETICS

*In the blood* Of the many changes which anesthetics may produce in the blood, I shall confine my remarks to the two which seem more closely related to the subject under consideration, namely, blood concentration and acidosis. Barbour and I (1, 2, 3) have shown that ether anesthesia causes the blood solids to increase by 2 to 3½ per cent of the total weight of the blood. This enormous blood concentration was found to be due chiefly to the migration of water from the blood to the tissues, considerable increase in the water content of the muscles having been shown following the anesthetics of the more powerful drugs, chloroform and ether. This blood concentration effect can be lessened markedly by the copious use of water or dilute solutions before, during, or after narcosis.

This brings us to that very grave feature of dehydration so often seen in the handicapped

patient, and to an important point in the selection of anesthetics. Intravenous injections of blood and isotonic solutions should be made prior to anesthesia, and the less toxic substances, nitrous oxide and cyclopropane chosen for administration, or, at least in some instances, it may be more propitious to resort to some form of regional anesthesia. More attention, than is generally customary, ought to be paid to the dehydrated patient who is about to be operated upon.

That acidosis is very liable to occur as a result of anesthesia has been abundantly proved, and Roscher has shown that it may take place even after local or spinal anesthesia. Stehle and I (4, 25) have demonstrated that phosphoric acid leaves the muscles during ether anesthesia and is neutralized by the bases, sodium and potassium. The phosphates are stored to some extent in the liver and, after recovery, when kidney function is resumed, they are then redistributed and partly excreted. Ronzoni, Koechig, and Eaton have given evidence that the lactic acid of the blood is increased, which harmonizes with the idea that phosphates and carbohydrates are intimately associated in metabolism, there being a common precursor, a hexose phosphate, called by Embden *lactacidogen*. Just recently, Pratt has shown that there is considerable variation in the effects of anesthetics on the blood-sugar level, and that even cyclopropane is capable of raising the blood-sugar. He states, "There is little evidence to suggest that the rise of blood-sugar is other than a welcome physiological compensatory phenomenon." Be this as it may, acidosis becomes a serious matter for the handicapped patient, especially he who comes to operation already in a condition of acidosis, as for example, the child with severe vomiting or the diabetic. It is our bounden duty, therefore, carefully to select those anesthetic agents and methods of administration which are least likely to produce or to enhance the acidotic state.

The choice lies between cyclopropane with nitrous oxide as a diluent, and spinal or local anesthesia. Of this latter, I shall have more to say later on. Of the former, it is timely to point out that the superfluity of oxygen, which is always given with cyclopropane, will very considerably lessen and prevent what little acidosis this gas

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1938 because of abdominal pain diarrhea and loss of weight and strength. He had had a posterior gastroenterostomy for duodenal ulcer performed 10 years before. His surgical convalescence at that time was not a smooth one nor had he ever been completely relieved of his symptoms. In recent years he had had several severe hemorrhages and about 2 years before we saw him a diagnosis of gastrojejunocolic fistula had been made. In spite of this condition he had remissions when he was reasonably comfortable and was able to carry on with his work as a wool broker. Bowel movements in the hospital numbered from 10 to 15 in 24 hours sometimes more and followed immediately the ingestion of food or fluid by mouth. Palliative treatment was wholly unsuccessful. On April 6th 2 weeks after he was first seen a jejunostomy for feeding purposes was done. In spite of intensive efforts to improve his nutrition 2 weeks later his blood serum protein had diminished further from 5.3 per cent to 3.5 per cent and the diarrhea persisted just as though food were taken by mouth. On April 20th 1 month after he was first seen and 2 weeks after his jejunostomy laparotomy was performed. A clasp type of operation was carried out. The transverse colon jejunum and lower two thirds of the stomach were removed between clamps. A Kerr end-to-end anastomosis was done on the transverse colon and on the jejunum and fortunately the third portion of the duodenum was so placed that it was readily anastomosed to the open end of the stomach. A cecostomy was then done. The patient made an uneventful postoperative convalescence except that 10 days after operation he had a sudden massive hemorrhage in the middle of the night and a day later a second hemorrhage though not so large requiring in all 3 transfusions. From then on there were no further complications and he left the hospital on June 6th, 2½ months after admission symptom free and in excellent condition.

Examination of the specimen showed the stomach connected with the jejunum by an opening 2.5 centimeters in diameter the edges of which were smooth the jejunum was connected with the colon by 3 openings the largest 3 centimeters in diameter each of the other 2 measuring 1 centimeter in diameter. In addition to these openings there was a jejunal ulcer 1.2 centimeters in diameter.

The number of operations which we have performed on the gastro intestinal tract is not large as shown in the accompanying table (Table IX). It is our belief however from this small experience and from a larger experience with gastro-intestinal surgery in non-diabetics and in diabetic patients with other lesions that (1) whenever possible every resection of the large bowel should be a 2 stage procedure regardless of the apparent condition of patient (2) a preliminary transverse colostomy is preferable to cecostomy preceding resection and anastomosis in patients with an obstructing lesion of the left colon provided the patient is having obstructive symptoms and a cleansing of the bowel above the obstruction is found to be impossible in all other instances a preliminary cecostomy should be under-

taken and (3) because of the relationship between infection and diabetes great care should be taken in the selection and execution of the surgical procedure so as to assure a minimum of local soil ing.

#### SUMMARY

One thousand, two hundred and seventy six operations upon patients with diabetes mellitus are reported. The case mortality is 8 per cent.

The importance of considering the effect of the diabetes upon the patient's cardiovascular renal system is stressed.

Five hundred and thirteen operations for gangrene are reported with a mortality of 13.1 per cent. The mortality for major amputations is 13.1 per cent. A primary supracondylar amputation was done in 51.8 per cent of the cases. In 100 consecutive supracondylar amputations for gangrene 93 per cent healed by first intention in only 2 of the infected cases did the infection involve the fascia.

Two hundred and four patients with good local circulation have had amputations of 1 or more toes for osteomyelitis or recurrent ulceration. There were 4 deaths a mortality of 2 per cent. In 18 cases a higher amputation was necessary, in 184 or 90 per cent of these patients complete healing occurred.

Important technical considerations for the drainage of infected feet are given. The importance of early hospitalization and adequate surgical treatment of infections of the hand is stressed and the results in 70 such cases are summarized.

Carbuncles are considered as surgical lesions. Electrosurgical drainage after adequate local and general preparation is advocated. Results after operations for appendicitis and cholelithiasis are given and a successful resection of the jejunum transverse colon and stomach for gastrojejunocolic fistula is reported.

#### BIBLIOGRAPHY

1. BORN, J. A. Surgery in diabetes. Pennsylvania M J 1934 37 661.
2. CALLANDER, C. L. A new amputation in the lower third of the thigh. J Am M Ass 1935 105 1740.
3. CHILMAN, F. P. The effect of anesthesia on hepatic function. Surgery 1935 3 87.
4. FREDET, J. and JEANNEVEY, C. La Chirurgie chez les Diabétiques. Paris: Rapport Ass. franç. de chir. 45th Congrès français de chirurgie 1936.

olism and of the effects of anesthetics on hepatic function, it is easy to see the importance of careful selection and administration of anesthetics in surgical procedures on the patient who suffers from liver disorders. Here again both methods and materials must be suited to the general condition as well as the special surgical requirements of a given individual. So much for some of the manifold amazements to be met in one organ.

*In the kidney* As changes, analogous to those which anesthetics produce in the liver, undoubtedly occur simultaneously in other organs, those which may take place in the kidney will be dealt with peremptorily. It has been known for a long time that anesthesia, generally, diminishes the volume of urine secreted, and data exist concerning the effect of anesthetics on metabolism as represented by the composition of the urine. In 1928, Stehle and I (26), by using dogs with fistulas in the bladder, showed that in ether anesthesia there is either a complete cessation in the formation of urine or a decided oliguria, that if the urea and the chloride concentrations are low in the control period, they may rise under ether anesthesia, but, when the initial concentrations are high, anesthesia causes a fall in the amounts and concentrations of the urea and chloride concentrations of the urine, and that a secretory mechanism is involved in contradistinction to the filtration-re-absorption theory regarding the secretion of urine. The previously mentioned blood concentration (1) found in ether anesthesia may now be seen to be closely associated with this diminished efficiency of the secretory process. Bruger, Dreyer and I (11) have made observations with avertin on dogs with bladder fistulas, and on man. We found that in the former anuria always occurred immediately after administration and lasted for a period varying between 15 minutes and 1 hour, after which marked oliguria supervened, whereas with the human cases, who received only one-fifth of the dose given to dogs, anuria did not take place, but there was pronounced oliguria. Nevertheless, throughout the periods of oliguria for both dog and man the percentage excretions of urea were always increased, which indicates that there is no evidence of severe kidney depression. During the postanesthetic period there is invariably an enormous excretion of phosphoric acid which is undoubtedly involved in the acidosis which was found to be present, and similar to that produced by ether. It has been shown by Waters and Schmidt that the urinary output is usually suppressed during cyclopropane anesthesia and a compensatory increase in excretion occurs several hours following anesthesia.

In fine, it may be said that all general anesthetics cause some depression of kidney activity, wherein the rate of secretion and composition of the urine is lowered. The degree of depression varies directly with the depth of narcosis and the effects are influenced by the condition of the kidneys, by the water content of the blood, and by the duration of anesthesia. With these factors in mind, it is evident that in surgical procedures on a patient handicapped by kidney disease, both the selection and the administration of anesthetics become matter and actuality of grave consequence.

#### CHOICE OF ANESTHESIA

Although it has been done rather discursively, yet I have attempted to show the close interrelationship of these 3 sets of ill-effects which occur in anesthesia, that is, upon the blood, the liver, and the kidney. So close is the connection that broadly they may be regarded as good examples of the disturbance which anesthetics produce on metabolism as a whole. This interpenetration of ill-effects simulates the great interlocking of the normal vital functions. It is timely, therefore, to consider more specifically a few of the salient features concerning the choice of anesthetics and the conduct of narcosis.

At once, that real emotion, fear, presents itself. In this most strenuous of Iron Ages, not nearly enough is being done adequately to assuage the throes of fear. We should cultivate the psychological approach rather than pooh-pooh it. We should win the patient's reliance by reassurances through soft voice and gentle gesture. Not until full confidence is gained will sedative drugs give their most favorable results. I believe that such drugs should be given more freely than is customary, but in smallish, repeated doses (especially for the aged or handicapped patient), begun sufficiently ahead of the time of operation in order that enough may be administered to almost completely obtund the activities of the cerebral cortex. Of the lot, it would seem that the combination of morphine and scopolamine is generally most desirable, and Waters (28), of the University of Wisconsin, who has been making observations with increased doses, finds "little if any change in oxygen consumption, a decreased minute volume with morphine alone, a slight increase with scopolamine alone, and a distinctly less reduction in the minute volume with the combination." These findings constitute an example of real synergism. Of course, when it is desirable to use avertin, this drug takes the place of morphine, and atropine only may be given with it. The most important reason for increased premedication is the removal

may perchance produce. With the proper alkaline state of the blood in view, whenever it is possible, the glycogen reserves of the body should be supported well before operation and after complete recovery from anesthesia. I dislike using glucose during operation because at this time there is apt to be hyperglycemia. It has long been my practice to administer a specially balanced hypotonic alkaline sodium and potassium phosphate solution immediately after operation, having demonstrated that nausea is markedly reduced and that this solution tends to stimulate the depressed individual (5). One pint of solution to every 50 pounds of body weight is given rectally. This bulky, watery, and alkaline solution not only reduces the acidosis but lessens the blood concentration and hastens recovery. This solution contains potassium ions which have been shown by Nothmann and Wagner, and Nothmann and Guttmann to be the most stimulating to any depressed, living thing, especially when the phosphate anion is present and when the medium is alkaline. Thus in particular, the handicapped patient is led more readily to a salubrious state. Needless to say fluids are not to be given to the patient with edema such as that from cardiorenal insufficiency.

So much then from a pharmacological point of view to a consideration of some of the ill effects which anesthetics may produce on the blood. So much, too, in consequence, concerning the choice of the drugs and the conduct of narcosis.

*On the liver.* The liver, with its immensity, its double blood supply, its 200,000 (Sappey) lobules possessed of orderly innermost arrangements, its many vital processes assimilatory and secretory and its diurnal rhythmic activity is truly a prodigious organ, the greatest in the body. Notwithstanding the redundancy of this huge structure it is very vulnerable and its cells are extremely susceptible to insult, so that in the very performance of their functions these cells succumb all too easily. Yet they are endowed with remarkable regenerative powers as has been shown separately by several sets of careful observers and reviewed extensively elsewhere (6). Suffice it to say now that Mann and Magath have demonstrated that it is possible to remove all but the two lower right lobes of the dog's liver, or approximately 70 per cent without serious damage to the portal and vena cava circulation. The animals do not seem to suffer from such loss. The reason for this may readily be ascertained by examination a few months after operation when the two remaining lobes will be enlarged and the amount of tissue practically the same as before operation. However despite liver regeneration despite the normal

appearance of the tissue under the microscope it has been conclusively proved, since the introduction of dye tests, that complete functional recovery is not fully established for some considerable time later, at least following the administration of certain poisons like phosphorus or chloroform. In other words, such a physiological test is more sensitive than any estimate based on histological evidence.

More recently, Rosenthal and I (23) studied the effects of various anesthetics on the liver, as indicated by bile pigment disturbances and by the bromsulphalein dye test for hepatic function. One result of our study was the conviction that the dye test affords a much more definite index of injury to the liver cells than do estimations of bile pigments in the blood and urine. Even after 15 minutes of chloroform inhalation healthy dogs always show considerable impairment of liver function, indeed, the damage is frequently so severe that recovery is not effected for 8 or 9 days. Two hours of chloroform anesthesia requires all of 6 weeks for return to normal. When ether is used similarly, the functions of the liver are definitely affected and proportionately to the degree and length of narcosis but they return to normal in about 48 hours even after a 2 hour period of anesthesia.

Our experiments with nitrous oxide, as well as with ethylene, showed that when sufficient oxygen is supplied, anesthesia from 1 to 2 hours produced neither immediate nor delayed impairment of hepatic function, whereas when the percentages of oxygen were purposely reduced, all the animals sustained an immediate impairment of function, which did not return to normal as with ether, but required about 6 days for recovery. This is an important lesson to learn, namely most carefully to avoid anoxemia during anesthesia.

Still more recently as investigations have revealed, that is, at least from a practical point of view, liver function is not disordered following the anesthetics produced by the derivatives of barbituric acid (7), by avertin (8) by urethane (9), and absolutely not at all by cyclopropane (20). In each of these instances the basic work was done on dogs, and with each drug verification was obtained from observations made on man. It may be pointed out at this juncture that in so far as we are presently concerned, the physiology of the dog's liver is identical with that of man's except that the dog's is somewhat more resistant to poisons and most cogently, the dog's dose of each of these substances is much greater than that of man's. For example, in the case of avertin it is 5 times larger. With these apposite, but cursory, considerations of the rôle of the liver in metab-

Since ephedrine possesses a stimulating action upon the central nervous system in general, as has been shown by various authors and recently studied more specifically by Raginsky and Bourne (21), it seems reasonable to suppose that in conjunction with the prolonged effects upon the heart and circulation, the central nervous system action of ephedrine plays some rôle in the complete restitution of the shocked animal." The united action of these 2 chemical entities constitutes perhaps the best known example of synergism in pharmacology.

Recently, O'Shaughnessy and I, at the Grace Dart Home Hospital for Pulmonary Tuberculosis and at St. Mary's Hospital, Montreal, have had cause to administer these 2 drugs 86 times, during that many spinal anesthetics, 23 in thoracic surgery and 63 for abdominal operations. Figures 2 and 3 are respectively illustrative. It may be stated that "2400" is the same "laboratory preparation" as used by Dr. Melville and was made in the department of pharmacology of McGill University. In the period of time over which this analeptic mixture was given during anesthesia on 86 occasions, there were 199 spinal cases at the two hospitals. The 113 others did not require analeptics during their operation periods, thus, herein is a proof of the firm belief which I have held for some time, namely, that analeptics should not be used routinely nor in anticipation of shock. They tend to stimulate the central nervous system. Raginsky and I (21), have shown that ephedrine reverses the effects of avertin and will undo the desired and purposely produced actions of morphine and scopolamine. What is more, it is known that stimulating drugs may cause contrary results when used in normal beings or prior to an indication. Again, the fact that analeptics were not needed in so many of these cases tends to prove the statements made above in favor of complete sedation, particularly that "there will be much less fall in blood pressure than otherwise."

Figures 2 and 3, with their legends, require little further elucidation. It will be seen in Figure 2 that the mixture of ephedrine and pituitary extract was given twice. This is seldom necessary. Usually, when it is deemed advisable to use these materials, their hypodermic administration will suffice. The intravenous avenue is not recommended unless the patient is very far gone (it was hardly indicated in the case recorded in Figure 2), because, on occasion, when this mixture is placed directly into the blood stream, the blood pressure and pulse rate will rise very alarmingly high.

<sup>1</sup>Of the pituitary extract preparations on the market, that known as pitressin has the greatest amount of pressor principle.

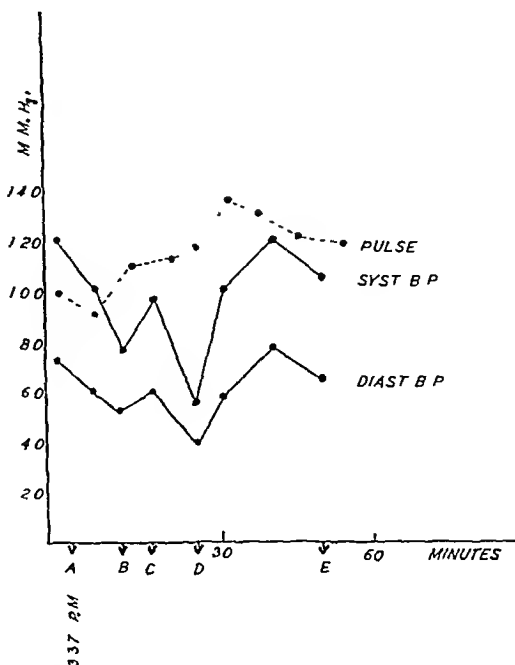


Fig. 2 M. L., a male, 24 years of age, date of operation was January 19, 1938, thoracoplasty performed first, second, and third ribs, left. At 2:00 p.m. one-fourth grain of morphine and one-hundredth grain of scopolamine were administered, at 3:00 p.m. one-fourth grain of morphine and one-hundredth grain of scopolamine were again administered. In both instances these were injected subcutaneously. A, Spinal injection of 14 cubic centimeters of one-fifteen hundredths of percaine solution, Etherington-Wilson technique, patient sitting up for 55 seconds, B, 5 units of "2400" with three-eighths grain of ephedrine injected hypodermically, C, operation begun, D, 5 units of "2400" with three-eighths grain of ephedrine given intravenously, E, operation finished, one-fifteenth grain of strychnine was administered subcutaneously, and 1000 cubic centimeters of 5 per cent dextrose was given intravenously.

In the case recorded in Figure 3 there was a moderate fall in blood pressure attendant on the intrathecal injection of percaine, a subsequent marked fall during the manipulations of the pylorus, and an excellent recovery following the hypodermic administration of the mixture of ephedrine and pituitary extract. It is pointed out at this time that we should not expect too much from this analeptic mixture. Other well established measures must not be neglected, indeed, the body fluids ought all the more to be sustained. Recently we have been in the habit of giving strychnine, 1/15 of a grain at the end of operation, and 1/30 of a grain every 4 hours after, for 3 more doses. This practice is rather empirical, but it is thought



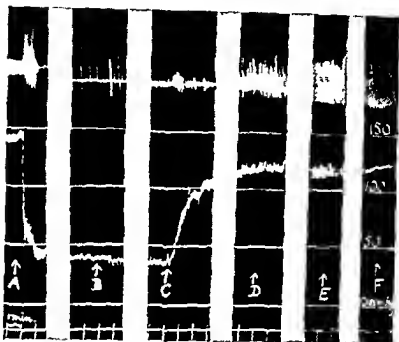


Fig. 1. Respiration and blood pressure tracings time recorded in minutes dog female 6.4 kilograms operative procedures under ether anesthesia. A Injection of histamine (0.5 milligram per kilogram per minute for 10 minutes) was started. B histamine stopped. C 10 minutes later a mixture containing 1 milligram per kilogram of ephedrine sulfate and 0.5 milligram per kilogram of pituitary extract (laboratory preparation) was injected. D, E, and F were 15, 30, and 60 minutes later respectively ether was required after E to keep the animal quiet.

of fear. The apprehensive, the frightened individual will all too often become severely shocked, particularly in spinal or other forms of regional anesthesia. If sedation is complete, there will be much less fall in blood pressure than otherwise little or no nausea and an agreeable grade of amnesia. With the exception of those who are *in extremis* I see no contraindication to the use of sedative drugs in the case of the handicapped patient all the more as it is recommended that small doses be given and only repeated in accordance with their effects.

**Analeptics.** At this juncture it may not be amiss to turn our attention to the analeptics. We have so little of exact knowledge about this group of drugs. I shall do no more than draw attention to some more or less recent work on the subject. Melville of the department of pharmacology of McGill University has demonstrated that when the pressor principle of posterior pituitary extract is mixed with ephedrine and administered to experimentally shocked dogs, the result is more effective than larger individual quantities of these

drugs in restoring blood pressure and respiration and in abolishing general collapse. Histamine causes a precipitous fall in blood pressure with marked slowing and irregularity of respiration so that the dog finally dies. If to such a shocked dog 2 milligrams per kilogram of ephedrine or 1 milligram per kilogram of pituitary extract is injected in either case, there results a temporary rise in blood pressure with some temporary restoration of respiration, but the animal rapidly relapses and dies shortly. If now, as is shown in Figure 1 (by permission of Dr. Melville), a similarly shocked dog is given intravenously a mixture containing 1 milligram per kilogram of ephedrine sulphate and 0.5 milligram per kilogram of pituitary extract, there occurs a sudden marked rise in blood pressure which is well maintained, the respiration becomes also definitely improved and soon owing to the apparent recovery of the animal, ether must be again administered. The effects are presumably not due solely to the circulatory actions of ephedrine and pituitary extract to arteriolar (ephedrine) and capillary (pituitary) constriction.

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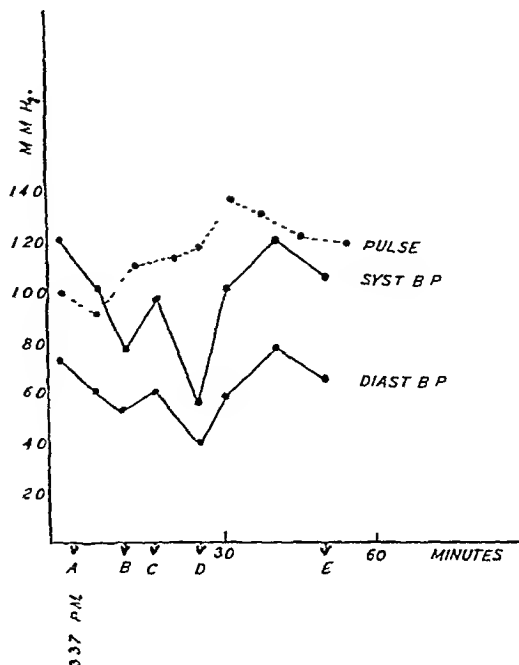


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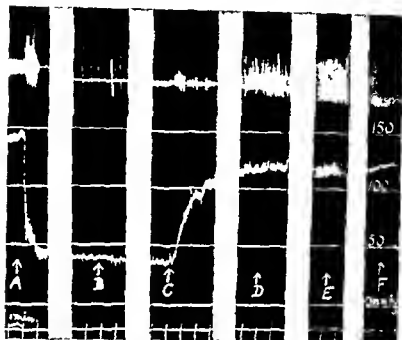


Fig. 2. Respiration and blood pressure tracings time recorded in minutes dog female 6.4 kilograms operative procedures under ether anesthesia. A Injection of histamine (0.5 milligram per kilogram per minute for 16 minutes) was started. B histamine stopped. C 10 minutes later a mixture containing 1 milligram per kilogram of ephedrine sulfate and 0.5 milligram per kilogram of pituitary extract (laboratory preparation) was injected. D E and F were 15, 30 and 60 minutes later respectively ether was required after F to keep the animal quiet.

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But, in execution, local infiltration, field block, and the different forms of nerve block anesthesia are found by a large number of surgeons to be tedious and time consuming. Spinal anesthesia, on the other hand, has become more particularly a part of the duties of the anesthetist and, in consequence, not only is the surgeon freed of the bother of it, but, through increased individual experience, the dangers have become almost negligible. The advantages of spinal anesthesia are very great, especially on account of the muscular relaxation and the excellent recovery. O'Shaughnessy and I (10, 14), have had very satisfactory results with the Etherington-Wilson technique for spinal anesthesia in more than 1200 cases. It would seem that spinal anesthesia is only contraindicated wherein, for one reason or another, the fall in blood pressure, which it frequently causes, is to be feared, as for example, in advanced cardiovascular disease. As mentioned before, it is very strongly recommended that relatively large quantities of depressant drugs be given prior to the production of all forms of regional anesthesia, that is, sufficient to thoroughly subdue the activity of the cerebral cortex and so replace fear by considerable bemusement.

*General.* Even for the patient who comes to operation without some additional disability, it is becoming more and more universally conceded that even ether anesthesia may be eschewed and place given to less disagreeable and less harmful substances. If this be true, then, how much more so must it be in the case of the handicapped individual. For the production of general anesthesia, I know of no better combination than avertin as a dyster to the patient in bed, about half an hour before the operation time—atropine may be given simultaneously—followed in the operating room by a mixture of cyclopropane, nitrous oxide and oxygen. The main object of the nitrous oxide is that of a diluent. More often than otherwise, it is advantageous to give these gases by the intratracheal method. In all cases of operations about the head, neck and chest (one thinks more particularly of those on the brain and on the thyroid gland) this method precludes respiratory obstruction and obviates interference with the surgical procedure from the anesthetist. This method also gives absolute assurance of a plentiful supply of oxygen directly to the lungs. Oxygen is always beneficial in anesthesia, and especially so in the incidents of blood dyscrasias, cardiac disorders, liver or kidney affections, and disturbances in general metabolism. Again this intratracheal method affords quieter breathing and a softer abdomen even though narcosis is not profound.

*Combination of regional with general anesthesia.* With respect to a combination of regional and general anesthesia, exigencies may arise in which there exist some good reasons against the use of pre-anesthetic drugs, or, at least, of large doses of them, then, for psychological purposes, the gases may be given together with the production of whatever form of regional anesthesia is chosen. The one supplements and enhances the power of the other, much less loss of the gases is required, and, then, too, the patient is all the better for the copious supply of oxygen contingent upon the performance. There are several surgeons and anesthetists who are very much in favor of the combination of these 2 procedures.

#### SUMMARY

1. Some of the effects of anesthetics on the blood, the liver, and the kidney are reviewed. As their interrelationship is explained, these effects are shown to be good examples of the disturbances which anesthetics produce on metabolism as a whole.

2. The blood concentration, the acidosis, and the impairments of the functions of the liver and kidney as well, which anesthetics may cause, are shown to be alleviated by the rectal administration of large quantities of a hypotonic solution of alkaline sodium and potassium phosphates.

3. In order properly to allay fear, relatively large doses of cerebral depressants are advocated, principally avertin or morphine and scopolamine.

4. It is shown that comparatively large amounts of morphine and scopolamine do no harm.

5. Analeptics are considered, and a mixture (Melville) of ephedrine with the pressor principle of posterior pituitary extract is recommended.

6. Data are presented concerning the clinical use of this mixture in spinal anesthesia.

7. The present liberal use of carbon dioxide is strenuously deprecated and reasons are given (Waters, 29).

8. For the handicapped patient, one of three procedures is recommended, namely, regional anesthesia, particularly spinal, general anesthesia with the gases, nitrous oxide and cyclopropane, especially by the intratracheal method; or, a combination of the two.

#### BIBLIOGRAPHY

1. BARBOUR, H. G., and BOURNE, W. Heat regulation and water exchange: the influence of ether in dogs. *Am J Physiol*, 1924, 67: 399-410.
2. BOURNE, W. Blood concentration and body temperature in anesthesia. *Brit J Anæst*, 1924, 2: 36-39.
3. Idem. The influence of diathermy in anesthesia on body temperature, blood concentration, and acidosis. *Brit. J. Anæst*, 1926, 4: 87-91.

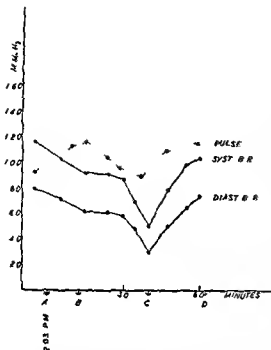


Fig 3 C R A male 36 years of age date of operation was April 20 1938. A gastro enterostomy with ligation of pylorus and appendectomy were performed. At 12:30 p.m. a subcutaneous injection of one fourth grain of morphine and one hundredth grain of scopolamine was done. This same injection was repeated at 1:40 p.m. A spinal injection of 15 cubic centimeters of one fifteen hundredths per cent solution was given. Etheration Wilson technique patient sitting up for 45 seconds. B operation begun C 5 units of 2400 with three-eighths grain of ephedrine administered hypodermically D operation finished. One-fifteenth grain of strychnine was given subcutaneously and 1000 cubic centimeters of 5 per cent dextrose was injected intravenously.

that through the action of strychnine on the spinal cord, muscle tone might be improved following spinal anesthesia.

Before we leave the topic of analeptics a few remarks upon carbon dioxide are relevant. Waters (29) has shown that carbon dioxide may produce convulsions that surgical shock is not the result of low carbon dioxide in the blood and tissues, that anesthesia does not cause a lowering of the carbon dioxide content of the blood and tissues that postoperative pulmonary atelectasis is not necessarily prevented by carbon dioxide and oxygen and that carbon dioxide is a waste product of body metabolism just as are the constituents of urine. Waters advises never to apply carbon dioxide therapy or rebreathing to prevent or ameliorate shock. Simple oxygen therapy is more satisfac-

tory. During anesthesia, dead space and rebreathing ought to be avoided as much as possible, and the carbon dioxide of the expired air removed by soda lime. Waters uses carbon dioxide solely as an analeptic when it is desirable to accomplish rapid elimination of toxic volatile gases and then a small stream of pure carbon dioxide is directed toward the face. These teachings, although directly antithetical to those of Vandell Henderson seem sound. It may be that untold harm has been done during the widespread employment of carbon dioxide, especially in anesthesia. It may be that the more its value as a drug is magnified, by so much the more will its true physiological significance be forever kept in mind. We must be wary of its use in the case of the handicapped patient.

#### ANESTHETIC PROCEDURES

Thus far I have repeatedly emphasized the importance of carefully selecting those anesthetic agents and methods of administration that are least likely to supplement any pathological condition which may exist in a patient about to be operated upon. I shall now be more specific, and state positively that in the light of our present knowledge we may make selection from 1 of 3 procedures, namely regional anesthesia that is local or spinal, general anesthesia with the gases nitrous oxide and cyclopropane or, a combination of the two. All other forms of anesthesia seem to be contra-indicated in the case of any kind of handicapped patient. In discussing these 3 procedures, I shall consider the anesthetic materials jointly with the means of their administration and try to show their suitability to the various types of handicapped patients which, broadly, may be regarded under the themes: anesthesia in brain surgery, anesthesia in cases of toxic goiter, that for thoracic surgery, chiefly pulmonary, for those with cardiovascular disorders, wherein there is myocarditis or failing compensation, those with impairment of liver function, for those suffering from the effects of intestinal obstruction, those with diseased kidneys, and, anesthesia on the occasion when the additional disability is some blood dyscrasia. Properly to investigate such a large question, or set of questions while it might yield great advantages is beyond the scope of this paper, yet some relevant inkings will be made.

Regional Procaine, nupercaine and pontocaine are the drugs just now in favor for producing regional anesthesia. Virtually they cause little, if any impediment in the vital processes. Their employment should therefore be encouraged.

# SYMPOSIUM ON UROLOGIC INFECTIONS

## RENAL INFECTION AND NEPHROLITHIASIS

GEORGE GILBERT SMITH, M D , F A C S , Boston, Massachusetts

THE number and excellence of recent articles dealing with nephrolithiasis bear witness to the importance of this disease.

It is no longer sufficient for the surgeon to remove the calculus, he must make every effort to secure satisfactory drainage of the affected kidney, he must take cognizance of the composition of the stone, so that by proper diet the patient may render his urine as unfavorable as possible for the formation of a similar stone, he must seek to uncover any metabolic disorder such as cystinuria or hyperparathyroidism predisposing to stone formation, and perhaps most important of all, he must clear up whatever infection exists in the kidney. Unless these objectives are achieved, the stone is likely to recur, and recurrent renal stone may be almost as fatal as is cancer.

These facts are well recognized, but we are far from having reached the point where we can prevent recurrence in all cases. This paper is concerned with a discussion of the infectious phase of the problem. The material upon which it is based comprises some 30 cases. These patients with renal stone were operated upon within the past 5 years, and the laboratory data are reasonably complete. Within that period, at least in our clinic, we have become much more aware of the value of chemical and bacteriological studies. Our education in this direction has in large measure been due to the co-operation of Doctor Fuller Albright, who has contributed a great deal to our understanding of the underlying causes of stone formation.

In working over this series of cases, one finds many regrettable gaps in the recording of cultures, stone analyses, and urinary findings. However, enough factual evidence has been recorded to enable us to make a number of deductions.

It is possible that infection outside the urinary tract is a factor in calculus formation, Randall (13) has shown that many renal stones develop on calcareous plaques located beneath the mucosa

from the Urological Department, Massachusetts General Hospital.

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at the apices of the pyramids, and has reproduced this lesion in animals by the administration of stable streptococcus hemolytic leucocidin. The experiments of Rosenow, in which he brought about the formation of stone in rabbits by injecting into their blood stream streptococci from devitalized teeth, suggest another possible cause of stone formation from extrarenal foci of infection.

*Aseptic stones* In this series, 5 patients had sterile urine when first examined. The stones in 4 were predominantly phosphatic in spite of the fact that the bladder urine was acid in reaction. There was no record of the composition of the fifth stone. In 4 the stones were multiple, in 1, single. One patient was proved by operation to have a parathyroid tumor. Although this small series of cases does not show it, we believe that many ovalate stones are not infected when first seen.

A discussion of the causation of aseptic calculi does not come within the scope of this paper. We must recognize the fact that in perhaps the majority of cases of nephrolithiasis, urine from the affected kidney shows no growth. Schneider, in a series of 181 stones, both renal and ureteral, found the urine infected in but 57.

*Bacillus coli* When we considered the bacteriological findings, both pre-operative and post-operative, in these 30 patients, we found that the *Bacillus coli* was the most frequent invader. It occurred 17 times, chiefly in conjunction with other bacteria and following operation. In 4 patients the *Bacillus coli* was found alone at the first examination, the calculus in 1 of these patients was phosphatic, in another it was composed of uric acid. There was no record of its composition in 2. Fisch states that *Bacillus coli* infection tends to form stones of calcium oxalate. It is my impression that as regards the problem of recurrent stone, the *Bacillus coli* is of no great importance. The organism can usually be killed by mandelic acid or prontosil, or even by methenamine plus acidification, provided there is good renal drainage. None of the patients with recurrent stones showed the *Bacillus coli* alone. Von Illyès says that the *Bacillus coli* can reduce the acidity

- 4 BOURNE W and STEHLE R L The excretion of phosphoric acid during anesthesia *J Am M Ass* 1924 83 117-118
- 5 BOURNE W On an attempt to alleviate the acidosis of anesthesia *Proc Roy Soc Med* 1926 19 49-51
- 6 Idem. Anesthetics and liver function *Am J Surg*, 1936 34 496-495
- 7 BOURNE W BRUGER M and DREYER N B The effects of sodium amytal on liver function: the rate of secretion and composition of the urine, the reaction alkali reserve and concentration of the blood and the body temperature *Surg Gynec & Obst* 1930 51 356-360
- 8 BOURNE W and RAGINSKY B B The effect of avertin upon the normal and impaired liver *Am J Surg*, 1931 14 653-656
- 9 Idem Vinyl ether (vinethene) anesthesia in dogs: effects upon normal and impaired liver *Brit J Anesth* 1935, 12 62-69
- 10 BOURNE W and O'SHAUGHNESSY P E The Etherington Wilson technique in intrathecal segmental analgesia *Canadian M A s J* 1936 35 5 6-540
- 11 BRUGER M BOURNE W and DREYER N B The effects of avertin on liver function: the rate of secretion and composition of the urine: the reaction alkali reserve and concentration of the blood and the body temperature *Am J Surg* 1930 9 82-87
- 12 LARSEN G Ueber die Wege des Kohlenhydratabbaus im Tierkoerper *Klin Wchnschr* 1921 1 401-403
- 13 ETHERINGTON WILSON W Intrathecal nerve root block: Some contributions and a new technique *Proc Roy Soc Med* 1933-4 27 323-331
- 14 GURD F B VINEBRO A M and BOURNE W Our experiences in the employment of spinal anesthesia for thoracoplasty *J Thoracic Surg* 1938, 7 500-511
- 15 MAAN F C and MAGATH T B The production of chronic liver insufficiency *Am J Physiol* 1922 59 485
- 16 MELVILLE K I Combined ephedrine pituitary extract (posterior lobe) therapy in histamine shock *J Pharmacol & Exper Therap* 1932 44 279-293
- 17 NOTHMANN M and WAGNER A Ueber die Wirkung von Alkalisalzen im Hinblick auf die Ausloesung tetanischer Symptome beim gesunden erwachsenen Individuum *Arch f exper Path u Pharmacol* 1924 101 17-27
- 18 NOTHMANN M and GUTTMANN E Ueber die Wirkung der Anionen insbesondere des Phosphats auf die elektrische Erregbarkeit. *Arch. f exper Path u Pharmacol* 1924 101 28-35
- 19 PRATT C L G Ether narcosis and carbohydrate metabolism. *Proc. Roy. Soc. Med* 1938 31 9, 1-978
- 20 RAGINSKY B B and BOURNE W Effects of cyclopropane on the normal and impaired liver *Canadian M Ass J* 1934 31 500-501
- 21 Idem Action of ephedrine in avertin anesthesia *J Pharmacol & Exper Therap* 1931 43 209
- 22 ROZOVIC E KOECHIG I and LAROV E P Ether anesthesia III Role of lactic acid in the acidosis of ether anesthesia *J Biol. Chem* 1924 61 463-492
- 23 ROSENTHAL S M and BOURNE W The effects of anesthetics on hepatic function *J Am M Ass* 1928 90 377-379
- 24 ROCHES F Investigations of postoperative acidosis and ketonuria *Acta chirurg Scand* 1933 74 Supp 29 1-238
- 25 STEHLE R L and BOURNE W Concerning the mechanism of acidosis in anesthesia *J Biol Chem* 1924 60 17-29
- 26 Idem. The effects of morphine and ether on the function of the kidneys. *Arch Int Med* 1924 42 243-255
- 27 WATERS R M and SCHMIDT E R Cyclopropane anesthesia *J Am M Ass* 1934 103 975-983
- 28 WATERS R M Personal communication
- 29 Idem Carbon dioxide *Canadian M Ass J* 1938 38 240-243

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*Staphylococcus*. In 6 patients, the staphylococcus was found in the stone-bearing kidney prior to operation. In 1 of these patients, it was in combination with the *Bacillus proteus*. In the kidneys from which it was obtained in pure culture, the calculus was composed of phosphates in 2, of ovalates in 1. In 2 of these patients a primary nephrectomy was done. In the other, the urinary infection cleared up after operation.

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*Bacillus pyocyaneus*. The *Bacillus pyocyaneus* occurred once. The patient showed bilateral renal calcification. His cultures showed in addition the *Bacillus proteus*, the *Bacillus coli*, and the alpha hemolytic streptococcus. After 2 series of treatments with prontosil, the above organisms disappeared, leaving the *Bacillus pyocyaneus* in pure culture. Intensive treatment lasting a full year failed to clear up this infection.

Roedelius reports a case of recurrent stone formation after pyelolithotomy in which the *Bacillus pyocyaneus* was the infecting agent. The first stone was an aseptic ovalate calculus, Roedelius believed that the *Bacillus pyocyaneus* entered the kidney by way of the drainage tract, starting from an unsterile, urine-soaked, outer dressing. The second stone was phosphatic, although the urine was acid. All known measures directed toward eradicating this organism were tried without success and eventually nephrectomy was done. The kidney showed a number of small abscesses,



of the urine (an important factor in the formation of recurrent stone), but clinical experience seems to show that it is not an organism to be feared.

*Bacillus proteus* The organism next in frequency to the *Bacillus coli* was the *Bacillus proteus*, public enemy No. 1 in the field of renal stone. We found it in 13 of our 30 patients. In only 4 instances was it present in pre-operative cultures, in the remaining 9 it appeared at varying intervals after operation. There were 5 patients whose kidneys were drained by a nephrostomy tube who did not develop a proteus infection, and 5 in whom the proteus first appeared after a nephrostomy. Seven pyelotomies without renal drainage were done; none of these developed a proteus infection. Fuller Albright has said that he has seen no instance of proteus infection in a patient who had not been subjected to urological instrumentation. In this series there were 2 patients who showed the *Bacillus proteus* in ureteral specimens at the time of their first cystoscopic examination. Both were women who had borne children so it is possible that they might have been catheterized at some time in the past. We believe, however, that primary proteus infection may occur, and we shall continue to search for an example of this which shall be beyond question.

It is disturbing to believe that so useful a procedure as nephrostomy may carry with it the danger of introducing the *Bacillus proteus*. Some of our urological staff hold the opinion that the continued presence of a rubber tube within the kidney is in some way responsible. It seems to me that the most probable explanation of the development of a *Bacillus proteus* infection after nephrostomy is that the organisms gain entrance to the kidney pelvis through the open channel of the tube during the postoperative period. We have not always been careful to keep the outer end of the tube free from contamination, and in a ward where there are always several patients with proteus infection, the bacillus may be introduced through careless handling of the tube through irrigations, or by letting the tube lie in infected urine.

Recent infections by the *Bacillus proteus* usually have not been difficult to eradicate, provided one realized the situation and at once applied the proper measures. The nature of these measures will be considered later.

A case which illustrates the importance of a proteus infection is that of a man 57 years of age who in October 1937 had a stone removed from his left kidney by pyelotomy. He was operated upon at another hospital, so we have not all the details of his history, but we do know that the stone was composed of a nucleus of uric acid and an outer layer of carbonates. The uric acid must have been

precipitated from an acid urine; the uric acid stone may then have led to infection, an alkaline urine and finally precipitation of carbonates. The surgeon found some constriction at the ureteropelvic junction which he dilated. Following operation the patient was given protilyn for 5 days, was put on an acid ash diet and had the renal pelvis lavaged a number of times. His bladder urine which he tested frequently, remained acid. We do not know about the urine from his left kidney. In July 1938 9 months after his operation x-rays showed a 2 by 1 centimeter calculus in the left renal pelvis. A pyelogram showed a definite dilatation of the pelvis with apparent narrowing at the ureteropelvic junction. The urine from the right kidney showed a hydrogen ion concentration of 5.0 that from the left a hydrogen ion concentration of 5.5. The *Bacillus proteus* in pure culture was obtained from the left kidney. Both renal functions were good.

On September 9, 1938 the stone was removed through a pyelotomy incision and proved to be composed of phosphates. A plastic was done on the ureteropelvic junction and the pelvis drained by a No. 14 French catheter drawn through the cortex. This was removed in 12 days as it was not draining too well; the sinus closed promptly. Between September 15 and 20 the patient was given 500 grains of sulfanilamide but did not tolerate it well. An intravenous pyelogram on September 29, 3 weeks after operation showed some dilatation of the pelvis. A left ureteral specimen on September 30 was slightly cloudy with 30 to 50 pus cells per high power field. The hydrogen ion concentration was 5.5. The culture showed the *Bacillus proteus* and the *Bacillus coli*.

*In vitro* studies on the susceptibility to protilyn of strains of *Bacillus proteus* as advocated by Long and Shes showed the following results. With an inoculation of about 100 organisms per cubic centimeter of urine, bacteriostasis started at 100 milligrams of protilyn per 100 cubic centimeters; the bacteria were killed by 500 milligrams per 100 cubic centimeters but not by 300 milligrams. The pelvis was irrigated and 1 per cent mercurichrome instilled. The patient was discharged from the hospital October 5 with instructions to force fluids, to take an acid ash diet, methenamine and ammonium chloride and to return for observation and possibly further pelvic lavage. If other measures fail, another more heroic trial of protilyn therapy would be considered.

Of the 5 patients in this series with recurrent stones 4 were infected with the *Bacillus proteus*. One was a typical stone former. In February 1935 this patient passed a stone from his left kidney. In November of the same year left ureterolithotomy was done. In February 1936 a left pyelolithotomy in October 1936 a right nephrolithotomy. Eventually the *Bacillus proteus* and the *Bacillus coli* infection cleared up under protilyn and mandelic acid therapy, but the left kidney showed no excretion of skodan and by retrograde pyelography irregular dilated calyces were demonstrated.

Cases similar to this can be called to mind by any urologist. Perhaps one kidney has been destroyed by repeated attacks of stone and has had to be removed. The other kidney meanwhile has become infected and possibly has required a permanent nephrostomy to keep it functioning at all. Stones continue to form, the renal tissue due to infection and poor drainage becomes increasingly inadequate. It is amazing to see on the autopsy table how little renal tissue suffices to support life. In most cases of this type I believe

you will find *Bacillus proteus*. On reviewing the history of the patient, you may find one critical moment when a more determined effort to clear up the infection, more radical surgery for the improvement of renal drainage, or even nephrectomy might have saved the second kidney from disaster.

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Fig 2 A pyelogram obscures the calculus and shows a constriction at the ureteropelvic junction



Fig 3 An intravenous pyelogram 3 weeks after removal of stone

the pelvic mucosa was raw and in places necrotic. A somewhat similar case had been reported by Fraenkels who according to Roedelius was the first to describe the serious consequences which might follow infection by the *Bacillus pyocyaneus*. That it is not always so pathogenic is shown by a patient recently examined, from whose ureteral specimens the *Bacillus pyocyaneus* was grown in pure culture. In spite of a considerable degree of lower ureteral obstruction due to cancer of the cervix and radiation this patient showed little evidence of toxicity or of renal damage due to infection.

Although they are not included in this series I would like to mention 3 cases of renal infection with an organism thought to be the *Bacillus* in fluenzæ. These have already been reported by Fuller Albright. Two of these patients showed bilateral stones with a tendency to calcification of the kidney tissue. The third who was the wife of one of these had a bilateral infection with the same organism but with no calculi. The urine of the 2 patients with stones was alkaline, the stones were phosphatic.

The treatment of renal infection for the purpose of preventing recurrent stone formation resolves itself largely into the eradication of the *Bacillus*

proteus. The bacteria which do not split urea are relatively unimportant as regards stone formation as a matter of course every infection should be cleared up if it is possible to do so. The staphylococcus infections have usually disappeared after the removal of the stone. If they persist I believe that intravenous administration of 0.3 of a gram of neo arsphenamin every 3 to 5 days for 4 to 6 treatments, is highly effective. I have used this treatment only in 3 cases but in every instance the infection cleared up. It is advised by Braasch, Anson, Clark, Keyser and other urologists of experience.

The treatment of the *Bacillus proteus* infection may be divided into its medical and its surgical phases. The use of drugs such as mandelic acid and methenamine which are active only in highly acid urine is of course irrational since it is very difficult to alter the urinary reaction when urea splitting organisms are involved. Our most effective acidifier ammonium chloride simply provides more urea for the bacteria to act upon. Chute has cited an instance in which stone recurred very quickly following its use in a kidney infected with the *Bacillus proteus*. Sulkowitch has suggested the use of strontium chloride. Silk has employed gluconic acid.



Fig 4 Bilateral calcification of the kidney due to the *Bacillus influenzae*



Fig 5 Bilateral calculi in a horseshoe kidney. The largest stone has been removed from the right kidney and a tube has been left in the pelvis. The stone on the left has caused the destruction of that kidney.

With the introduction of prontylin, the need for an acidifying agent has seemed less urgent. Reports as to the success of this drug have been somewhat conflicting. In my own experience, the infection has yielded to a relatively small dose—40 grains a day—with improvement evident 4 or 5 days after treatment was started, or the infection has not yielded at all. I must confess that in some instances my courage has not been equal to the occasion. I have been so terrified by the appearance of the patient who is blue, apathetic, sometimes almost comatose that I have not had the hardihood to continue the drug. Having had one man of 75 years of age almost die from a bronchopneumonia which seemed to be directly due to such a state as this, and still carry his proteus infection, I have become a half-hearted therapist so far as large doses of prontylin are concerned.

A highly satisfactory discussion of the mode of action and the clinical use of sulfanilamide in urinary tract infections has been published recently by Long and Bliss. They suggest that the effect of sulfanilamide upon the particular strain of bacteria should first be tested *in vitro*. When the lethal concentration has been ascertained, one is in a position to give the drug in quantities suf-

ficient to produce the same concentration in the urine. About one half of the organisms tested were inhibited in their growth by a 50 milligrams per cent concentration of sulfanilamide, and practically all were inhibited by a concentration of 200 milligrams per cent. Since they found that only about 50 per cent of sulfanilamide is excreted in the active form, to obtain the latter strength, a dosage of 120 grains of sulfanilamide per day with a urinary output of around 2000 cubic centimeters would be required. Four strains of the *Bacillus proteus* were tested *in vitro* by these authors. Even with a concentration of 200 milligrams per cent sulfanilamide, bacteriostasis was only slight in 2, and moderate in 2. This concentration was not bactericidal in any of the strains.

Since, therefore, we have no reasonably certain internal medication upon which we can rely, we must turn to the direct application of therapeutic media to the kidney pelvis. This may be done through the ureteral catheter, or through a nephrostomy tube. Randall (12), in 1932 suggested the use of 1 per cent phosphoric acid in the renal pelvis as a deterrent to the activity of the urea-



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splitting bacteria. He obtained a number of cures by this method. Von Illyes employed silver nitrate, Albright has suggested the use of a solution of sulfanilamide as a pelvic irrigation.

Of the 13 patients with the *Bacillus proteus* infection 2 had primary nephrectomies and their urine became sterile. One, however, has passed a stone from his remaining kidney. Three had secondary nephrectomies, all about one year after the first operation. All 3 had obstruction at the ureteropelvic outlet; their kidneys were in various stages of disintegration. Stone had recurred in 1; in another, 2 fragments left behind at the first operation showed little increase in size. These patients had had nephrostomies, but were victims of faulty drainage. Four that had nephrostomies got rid entirely of their infection. One patient who had a nephrostomy remains infected; one is still in the hospital but with a strongly acid urine he promises to become free from infection. One was cured by sulfanilamide and mandelic acid. In one the *Bacillus proteus* continued in spite of sulfanilamide: 100 grains a day for 8 days were administered.

The surgical measures to be employed in patients with infected stone-bearing kidneys are various and should be based upon a thorough knowledge of the facts. The size, shape and distribution of the stones, the separate functions of the kidneys, the type of infection present, the condition of the other kidney, all influence one's treatment of the diseased organ. Two ends must be kept in mind: prevention of stasis and eradication of infection. If it appears unlikely that all fragments can be removed, nephrectomy should be considered if the other kidney is sound for in my experience it is seldom that one can sterilize a kidney in which are left pieces of stone. This rule is not absolute of course but generally speaking a bit of infected stone is a sure cause for recurrence. The same principle holds in cases of stasis: even if the kidney is not infected previous to operation it probably will become so afterwards. With a kidney which shows a marked degree of hydronephrosis the operator should consider nephrectomy. Conservative renal surgery about which so much has been written is eminently desirable but a better guarantee of future health is to remove a kidney which has too many potentialities for getting into trouble. If the upper or lower calyx is dilated resection of the corresponding renal pole is a wise precaution.

Nephrostomy is a time honored procedure which has been thought well of by many urological surgeons. Cumming, writing on the value of prolonged nephrostomy drainage after removal of

calculi cited von Lichtenberg, Chute, Cabot, Bugbee, Winsbury, White, Papin, and Crosbie as favoring nephrostomy in some instances for long periods. Counsellor and Hoerner agree that nephrostomy aids the eradication on infection and the restoration of function. After analyzing a series of 187 patients operated on for renal stone at the Mayo Clinic in the years 1929 to 1933 these authors concluded that the results when nephrostomy was done were better than those when it was not done despite the fact that the kidneys subjected to drainage were more severely damaged originally.

Von Illyes writing on recurrent calculi said that he had 6 per cent recurrences after 81 nephrotomies, against 8.7 per cent recurrences in 510 cases of pyelotomy or ureterotomy. He comments on the value of transrenal drainage when clots are present, especially if infection exists and in kidneys with dilated, stiff walled calyces. It is his custom to remove the tube in 6 to 8 days.

In the series of cases upon which this paper is based a catheter was drawn through the renal cortex into the pelvis in 11 patients. The tube was left in for 12 or 14 days in almost all of these cases but in one patient it was left for 4 months.

The value of prolonged kidney drainage is illustrated by the following history:

The patient, a man 44 years of age, entered the Baker Memorial Hospital on January 20, 1936 with anuria of 5 days duration. His non protein nitrogen was 125 milligrams per cent. X rays showed a horseshoe kidney, the left half of which had been destroyed by a stone impacted in the upper ureter. On the right there were 4 stones, one 3 centimeters in diameter and 3 smaller ones. The ureters were catheterized; only a bougie could be passed to the left kidney. A catheter was left in the right kidney for 3 days. As drainage through this catheter was inadequate on January 22 the large stone on the right was removed through a pyelotomy and a catheter drawn into the pelvis through the cortex. The urine at this time showed no growth. Eighteen days after operation it showed the *Bacillus coli* and the *Bacillus proteus* and one month after the *Bacillus proteus* alone. Three weeks after the operation upon the right kidney the left kidney which was found to be functionless was removed. The patient was discharged from the hospital with a catheter in the right kidney. This catheter he kept closed but he irrigated his renal pelvis twice a day with potassium permanganate. He took picric acid orally for 4 weeks then methenamine. Three months after his first operation he passed the 3 small stones that had been left in the kidney. Four months after operation his urine was clear and constantly acid. The catheter was removed for good having been changed several times in the meantime. For 3 1/2 years he has been under observation. No new stones have formed and his urine is acid and free from pus.

The employment of nephrostomy in an infected kidney is in accordance with surgical principles. It provides free drainage which is essential in the clearing up of infection. It enables one to

wash out old blood clot, bits of fibrin and necrotic tissue, and to irrigate the renal pelvis with bactericidal solutions, with those designed to change the reaction of the urine, and with those calculated to dissolve the bits of crystalline material which may be adherent to ulcerated areas in the pelvis or calyces. All these factors are important in preventing the formation of new stones, and in bringing about the sterilization of the kidney. I am not sure that it matters greatly what solution is employed. Potassium permanganate, 1:3000, is a good solvent of mucus, mercurochrome, boric acid, silver nitrate, phosphoric acid, acriflavine, and doubtless many other solutions have been used. The mechanical effect is probably the most important.

The same holds true with postoperative lavage of the renal pelvis through a ureteral catheter. This measure is often neglected, but I believe it to be of great value in certain situations. It is especially useful if there is any question of obstruction to drainage, both because of the effect of irrigation and that of dilatation. Keyser emphasizes the latter effect, he dilates the ureter, sometimes to a No. 16 French catheter.

If simple pyelotomy is done, one should not discharge the patient until his urine is sterile. The administration of appropriate urinary antiseptics and if necessary, lavage of the renal pelvis, should be continued until the infection is eradicated.

#### CONCLUSIONS

1 Renal infection is not a factor of major importance in the formation of the majority of primary renal calculi.

2 In the formation of recurrent stone, with the exception of those due to hyperparathyroidism and to cystinuria, infection is of the greatest importance.

3 In such cases, the *Bacillus proteus* is the organism most commonly found.

4 The urologist's duty is not fulfilled with the removal of the stone, he must then employ

every possible known measure to eradicate the renal infection.

5 In order to do this successfully, he must vary his surgical procedure according to the circumstances of the case. This may mean nephrectomy, partial nephrectomy, nephrostomy, or pyelotomy.

6 No case of renal stone should be regarded as satisfactorily concluded until the urine has become sterile.

#### REFERENCES

- 1 ALBRIGHT, F. Personal communications.
- 2 BARNEY, J. D., and SULKOWITCH, H. Progress in the management of urinary calculi. *J Urol*, 1937, 37 746-761.
- 3 COUNSELLER, V. S., and HOERNER, M. T. Analysis of effectiveness of nephrostomy in treatment of large calculi. *J Urol*, 1936, 35 21-31.
- 4 CUMMING, R. E. The treatment of bilateral renal and ureteral calculi. *J Urol*, 1934, 32 600-623.
- 5 EISENSTAEDT, E. J. S. Discussion. *J Urol*, 1934, 31 251-253.
- 6 FISCH. Quoted by von Illyès (v infra).
- 7 HAGER, B. H., and MACATH, T. B. The formation of vesical calculi. *J Am M Ass*, 1928, 90 266-271.
- 8 HELLSTROM. Quoted by von Illyès.
- 9 KEYSER, L. D. Recurrent urolithiasis, etiologic factors and clinical management. *J Am M Ass*, 1935, 104 1299-1306.
- 10 LONG, P. H., and BLISS, E. A. Observations upon the mode of action and the clinical use of sulfanilamide in urinary tract infections. *South M J*, 1938, 31 308-315.
- 11 PILLET. Quoted by von Illyès.
- 12 RANDALL, A. Prevention of the recurrence of urinary calculi. *Am J Surg*, 1932, 18 482-493.
- 13 Idem. Studies on the pathology of the renal papilla. *J Am M Ass*, 1937, 109 1698-1702.
- 14 ROEDELIIUS, E. Unusual pyocyanous infection of urinary passages with new stone formation following pyelolithotomy. *Deutsche Ztschr f Chir*, 1936, 248 167-173.
- 15 ROSENOW, E. C. Production of urinary calculi by devitalization and infection of teeth in dogs with streptococci from cases of nephrolithiasis, summary of results. *Illinois M J*, 1926, 49 28-33.
- 16 SCHNEIDER, E. Primary and secondary aseptic nephrolithiasis. *Med Klin*, 1937, 33 1089-1092.
- 17 TWINEM, F. P. Recurrence after operations for nephrolithiasis. *J Urol*, 1937, 37 259-267.
- 18 VON ILLYÈS, G. Recurrent calculi, frequency and causes. *J d'uroi*, 1934, 38 419-432.



# PYELONEPHRITIS AND ITS TREATMENT

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**B**EFORE we go any further, let us first get straight what we mean by the term pyelonephritis. It is generally recognized that there are two distinct types of renal infection, namely, a primary hematogenous infection predominating in the renal cortex and a lesion predominating in the central portion of the kidney, which is usually called pyelonephritis. The path of infection with pyelonephritis is generally regarded as ascending rather than blood borne and the bacteria usually belong to the bacillary group. To repeat, there are two distinct types of renal infection: type 1, the cortical hematogenous infection often requiring surgical treatment; and type 2 pyelonephritis, usually ascending from the lower levels of the urinary tract, with predominant bacillary infection and seldom requiring surgical treatment.

The subject of renal infection, however, is not as simple as this schematic outline would suggest, since many variations and a mingling of the two types are often observed. Nevertheless, there are definite clinical data which differentiate these two groups and which should be recognized in the clinical consideration of the subject. The type of renal infection that I am discussing is the ascending form of infection or pyelonephritis. If pyelonephritis is an ascending infection, how does it get up into the kidney from the genitalia and lower urinary tract? That is a problem which remains unsolved. However, the two most probable avenues are through the ureter and through the lymphatics. How can the infection ascend directly up the ureter in the face of peristalsis? This is explained by a combination of possible back pressure, incompetent ureterovesical valve and reverse peristalsis, the latter occurring more frequently than is generally realized.

## TYPES OF PYELONEPHRITIS

In the discussion of pyelonephritis let us recognize that there are three clinical phases of this disease, namely, the acute, recurring and chronic forms. Acute pyelonephritis is by far the most common lesion in the genito-urinary tract. In fact, next to respiratory infection, it probably is more common than infection in any other field.

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Pyelonephritis occurs more frequently in the female in its acute form and more often in the male in its chronic form. This is due to the greater susceptibility of the urinary tract in the female to acute ascending infection and on the other hand to the fact that there are chronic foci of infection in the prostate and adnexa which are the usual basis for chronic pyelonephritis in the male. Most cases of acute pyelonephritis in either child or adult are of short duration and are self-limiting. The medicine we give these patients is often given credit for clearing up infection which in reality has been overcome by natural resistance. However, when the infection persists longer than 4 or 5 days and when it is accompanied by fever and chills, nature is materially aided by the administration of any of the various chemotherapeutic agents now available.

The second form of pyelonephritis to be considered is characterized by recurring attacks of acute pyelonephritis. The periods of infection may persist over several weeks or months and recur after a variable lapse of time. In the interval, although the patient is free of symptoms, careful and persistent search of the urine will often show the presence of a few bacteria, indicating that the renal infection in most of these cases is dormant rather than eliminated.

The third type of pyelonephritis is its chronic form and this is the most difficult to overcome of the three. The first two types of renal infection usually will respond to recently developed chemotherapy and control of the etiological factors, but chronic pyelonephritis offers an entirely different problem. In using the term chronic pyelonephritis, I refer only to those cases in which renal infection has persisted over a period of at least 1 year. Chronic pyelonephritis involves both kidneys with rare exceptions. In fact, when only one kidney is found to be infected over a long period of time, it can be assumed that a secondary complication is present which in most cases will necessitate surgical treatment. Chronic pyelonephritis often runs a course of many years without great curtailment of life or its activities. Unless complications occur, patients usually suffer only from dysuria and frequency and in many cases become inured to it. In about 50 per cent of cases immunity is developed and the infection is gradually

eliminated. In others, however, such complications develop as secondary lithiasis, hematuria, and ureteral or pelvic obstruction as the result of cicatricial deformity. In still other cases the infection and cicatricial changes in the renal tissue curtail glomerular activity so that the renal function suffers materially, with the usual symptoms. In a few cases this destructive process is confined to one kidney and the condition may then require surgical treatment.

There is no doubt that the infecting organism in the female ascends through the urethra into the bladder much more frequently than is generally recognized. Countless women who complain of urinary frequency and dysuria—the so called irritable bladder—in most cases will be found on endoscopic examination to have evidence of infection in the urethra. The treatment in these cases should start with elimination of vaginal infection, chronic cervicitis, and infection in the periurethral glands and tissues. Urethritis, so often overlooked, lends itself readily to such simple treatment as dilatation of the urethra if this is found to be cicatricial, and the application of antiseptics, such as protargol or argyrol, by



Fig 2 Bilateral pyelonephritis with cicatricial changes in pelvis of left kidney, characterized by constriction of infundibulum and bulbous enlargement of upper calyx. Contraction of other calyces.



Fig 1 Chronic bilateral pyelonephritis. Deformity predominant in ureter, characterized by cicatricial irregularity and atonic dilatation in the upper third.

means of urethral suppositories or tampons. Urethritis is frequently accompanied by an eroded or prolapsed urethral mucosa. This should be treated by a combination of local applications and soothing ointments, never by cauterization. Of primary importance also is the elimination of all possible distant foci of infection. By taking these simple precautions in the female, most cases of persisting or recurring acute urinary infection can be overcome. Similarly in the male, recurring attacks of pyelonephritis can usually be traced to a persistent, virile infection in the prostate. In curbing reinfection, the usual treatment of massage is greatly aided by liberal doses of sulfanilamide compounds.

Another form of renal infection which assumes the clinical character of a glomerular nephritis rather than that of pyelonephritis is sometimes observed and requires special consideration. Although the clinical data resemble those accompanying nephritis and are frequently influenced by a variable degree of renal insufficiency, nevertheless its infectious nature is disclosed by the presence of pus cells in the sedimented urine, and with persistent effort and refined methods of culture, bacteria can often be found. Its infec-



Fig 3 Bilateral pyelonephritis. Calicinal changes involving calyces characterized by constriction of infundibula and clubbing of lower calyx. Atonic dilatation in the lower segment of ureter on both sides.

tious nature is corroborated by the fact that the administration of sulfanilamide and its derivatives has been followed by definite improvement. Although these drugs may not be eliminated in the urinary tract when the renal function is reduced nevertheless their systemic action may have a bactericidal effect. I have observed a number of patients with acute exacerbation of renal infection accompanied by renal insufficiency who could not tolerate oral administration but who improved to a marked degree following the subcutaneous injection of prontosil and sulfanilamide.

Retention of urine is a common and often serious complication following intra abdominal and pelvic operations. It almost invariably follows resection of the lower bowel for malignant lesions because of temporary injury to the innervation of the bladder. Unless the retention is relieved distention of the bladder with renal back pressure and infection will result. Catheterization is usually necessary and should be done promptly. Otherwise secondary infection which usually follows will ascend to the kidneys. By the simple expedient of giving the patient 5 grams

or 0.3 grams, of sulfanilamide 3 or 4 times a day starting immediately after the operation renal infection from postoperative catheterization usually can be overcome.

In the treatment of recurring or chronic renal infection the first step to take is to make sure that the infection is primary and not secondary. Pyelonephritis which is secondary to some underlying lesion such as stone, tuberculosis or obstruction in the bladder or ureter probably occurs more frequently than does primary renal infection.

These factors having been excluded the next thing is to determine the type of bacteria present. If there is any one thing that has been learned in the development of modern therapy of urinary infection, it is the necessity of a working knowledge of bacteriology.

It would seem that necessity has made bacteriologists out of urologists or to be more accurate has made urological bacteriology. For the purpose of the average clinician however, it is necessary to be familiar with only a few simple observations in bacteriology. Microscopic differentiation between the two main groups of bacteria, namely bacilli and cocci is essential to adequate diagnosis.



Fig 4 Bilateral pyelonephritis. Calicinal changes in calyces with bulbous enlargement of all calyces and atonic ureteral dilatation in the lower segment of the right ureter.

Why is it necessary to differentiate the bacteria? For the simple reason that some bacteria respond better to certain drugs than to others. It is true that it may not be necessary to know the exact bacteria involved if the infection yields readily to routine chemotherapy. However, this is not the rule, and when the infection persists or recurs a bacterial study is essential to successful treatment. The main types of bacteria can be recognized easily and without elaborate laboratory facilities. For practical purposes the simple Gram stain of the dried urinary sediment may suffice. Microscopic examination will readily determine the presence of cocci or bacilli and whether they are gram-negative or gram-positive. Although gram-negative bacilli are most commonly observed with pyelonephritis, any type of bacterium may be present and in many cases the bacteria are mixed.

When it is desirable to identify the various types of gram-negative bacilli, cultures can be made from the urinary sediment. The 3 bacilli which occur most frequently and have the greatest clinical significance are the colon bacillus, its tough little cousin aerogenes, and the tenacious *Bacillus proteus*. It is desirable to distinguish the latter because it splits urea, causes alkaline urine, and may be hard to eliminate. Of the cocci the gram-positive cocci, including staphylococci, are more frequently seen than streptococci. One form of streptococcus, however, the weakly *Streptococcus faecalis*, is frequently found in the urine, either alone or more often in conjunction with bacillary infection. It can usually be recognized by its shape and its peculiar appearance with the Gram stain.

Let me warn the readers, however, about one thing. Just because the patient's symptoms disappear and there is no longer pus in the urine, it does not mean that the infection is completely eliminated. Time and time again I have seen symptoms disappear completely after a short course of treatment, microscopic examination of the urine revealed no pus cells and the patient was allowed to go rejoicing. Within a few weeks or months, however, the symptoms recurred and often an acute infection followed. This could have been obviated easily by remembering the fact that bacillary infection frequently persists when symptoms and pus cells disappear. It is essential, therefore, in the employment of any form of treatment, that Gram stains or cultures of the urine be made for some time after the symptoms disappear and that the treatment be continued for several days after cultures have become negative.

#### RECENT DEVELOPMENTS IN THE TREATMENT OF URINARY INFECTION

In no other field of medicine has there been a more revolutionary change in therapy than has taken place during the last 3 years in the treatment of infections in the urinary tract. Recent developments in chemotherapy have completely altered our theories and methods of treatment. The genesis of these recent therapeutic agents reads like a romance. Progress from acidification of the urine to the ketogenic diet and the use of mandelic acid in the treatment of urinary infection now seems logical and simple, but in reality it represents giant strides.

Mandelic acid is being largely replaced by the more efficient sulfanilamide-like compounds. Its use is limited largely to certain bacillary infections and it is effective only when the urine is made highly acid, which in itself is often either objectionable or impossible. However, occasionally it will eliminate bacilli when the sulfanilamide compounds fail to do so, and it is peculiarly bactericidal against *Streptococcus faecalis*. Occasional cases are observed in which bacillary elimination is possible only by the combined use of mandelic acid preparations and a modified ketogenic diet. Mandelic acid is often used when the patient is unable to take sulfanilamide.

It was only in 1935 that Domagk discovered the bactericidal properties of prontosil with infection in mice, and soon after this the observation was applied to human infection. Since then this drug and its derivatives have swept like wild fire across the therapeutic horizon, so that today it probably is used more widely and for a greater variety of infections than any other drug in the history of medicine.

These two drugs have given us means to combat infection in the urinary tract far more efficaciously than ever before. It will be impossible in this paper to give adequate consideration to these therapeutic agents. It will be possible only to refer to some of their more important qualities and to a few recent observations which have been made on their use.

Sulfanilamide is bactericidal against all bacteria appearing in the urinary tract. Its efficacy varies in degree, however, with the type of bacteria present, the pathological condition of the tissues involved and the degree of immunity on the part of the patient. Sulfanilamide is particularly efficacious in urinary infections with the colon bacillus, *Aerobacter aerogenes*, proteus and their brethren. It has been a godsend in the cases of infection with proteus, which in the past has been most difficult to eradicate from the urinary

tract. It is less efficacious with coccal infections, although more often than not it will eliminate them. Sulfanilamide is almost impotent against *Streptococcus faecalis*, and it will usually be necessary to fall back on mandelic acid therapy in order to eradicate this organism.

The action of sulfanilamide varies widely so far as the patient is concerned. It is most efficient in children and in younger adults, who seldom experience any toxic reaction. In the elderly patient it should be given with care, since it seems to be far more toxic and its use is often accompanied by marked acidosis. The greatest objection to it is undoubtedly its toxic effect, which limits its use in many adults over 40 years of age.

The drug manifests its toxicity in many ways, which by this time are well known to almost everyone such as malaise, gastric symptoms, weakness, skin eruptions, and so forth. Most dangerous and insidious are changes in the blood characterized by agranular leucopenia. It is curious that those who use it most widely and in the largest doses seem to observe less violent reactions than those who use it occasionally. It should be made emphatic, however, that where blood changes and the subjective symptoms of toxicity are apparent, its use must be discontinued immediately or resumed with great caution and in small doses.

In regard to the tissues involved, experience has shown that sulfanilamide is not of much value in tissues which have recently been traumatized as at operation. For instance following renal plastic operations or transurethral prostatic resection the drug has little or no influence on the infection in the tissues involved. However if the infection persists a month or so after the tissues in the operative field are healed sulfanilamide may be of value in eliminating the infection.

Sulfanilamide seems to be least efficacious with advanced chronic pyelonephritis because of secondary anatomical changes in the renal tissues. There is a vast difference in the results obtained in therapy for chronic and for recent renal infection. With chronic pyelonephritis the cicatricial changes surrounding a localized area of infection are such that the drug apparently cannot function. It is true that many patients with chronic pyelonephritis will respond to the drug to a remarkable extent and in many cases the infection may eventually be eliminated. However, when the infection is widespread when accompanied by such complications as hematuria, secondary lithiasis, or interference with renal drainage the chances for improvement are not too good. In

former years several hundred patients with chronic pyelonephritis were observed annually at The Mayo Clinic. In spite of the fact that recent chemotherapy has been employed only a few years, the number of these patients observed today is only a fraction of that formerly seen. This reduction is probably due to two causes: first, the efficacy of chemotherapy in the uncomplicated cases of chronic pyelonephritis and second the fact that chronic pyelonephritis is being prevented by overcoming the infection in the acute and subacute forms. There is no doubt that sulfanilamide and its derivatives have already reduced the incidence of chronic pyelonephritis and they bid fair to control if not eliminate one of the most trying diseases involving the urinary tract.

Repeated efforts have been made to modify sulfanilamide or to find substitutes which would not have its toxic qualities. Although prontosil was first employed in combating infection it was supplanted in clinical use by sulfanilamide because the latter seemed more bactericidal. In view of the fact, however, that prontosil is less toxic, there has recently been a tendency to return to its wide employment. Modifications were made which rendered prontosil more soluble and the resulting compound is called neoprontosil soluble. This compound which will soon be available for general use apparently has the same bactericidal qualities as sulfanilamide, but is much less toxic. It probably will be widely employed as soon as it is released by federal authorities for general use.

It is now being realized that large doses of sulfanilamide compounds are unnecessary in many cases of infection in the urinary tract. Smaller doses, frequently as small as 5 to 15 grains, or 0.3 to 1 gram daily will often suffice to keep the infection under control and will usually cause no toxic reaction. This is particularly true with chronic or recurring attacks of pyelonephritis. If these small doses are administered continuously to the patient in the interval between attacks, recurrence is frequently prevented. Small doses may also be of value with chronic inoperable pyelonephritis complicated by either primary or secondary ureteral obstruction or stone. I have observed patients suffering from advanced chronic pyelonephritis with poor renal drainage and others with extensive bilateral renal lesions and secondary renal infection who when given 5 grains or 0.3 gram, of sulfanilamide daily over a period of a month reported that the urine cleared to a large extent and that the febrile attacks were prevented. However, when

sulfanilamide is given preliminary to renal operations, it will seldom eliminate secondary renal infection unless the primary lesion is corrected.

Theoretically, it would seem that if correctly prepared, vaccines, antigens and the like should be of therapeutic value. Although vaccines were formerly employed widely in combating renal infection, as a result of unsatisfactory experiences their use has been gradually discontinued. Recently attempts have been made to modify their preparation with some success. These modifications consist largely of greater care in obtaining the infecting organism, dilution of the strain in culture, preparation of the vaccine after shorter incubation, and detoxication by means of salines. They should be of value particularly with coccal and proteus infections, which often resist all forms of chemotherapy.

Although surgical intervention is not usually indicated in the treatment of chronic pyelonephritis, certain secondary complications may develop which can be relieved only by operation. Included among these complications are ureteral obstruction causing inadequate renal drainage, unilateral infection accompanied by recurring febrile attacks which resists all forms of chemotherapy, and unilateral destruction of renal function, with renal atrophy. In a recent review of 526 cases of chronic bilateral pyelonephritis observed at The Mayo Clinic, surgical treatment was found necessary in but 17, or 3 per cent. It goes without saying that with pyelonephritis developing secondary to primary lesions such as pyelectasis and renal lithiasis it is necessary to relieve the underlying condition by surgical measures. One of the best reasons for urging early operation for renal lithiasis or hydronephrosis is that, if secondary renal infection exists too long, it may be difficult to eliminate, even if the primary lesion is removed. Attempts made to overcome primary chronic pyelonephritis by such surgical means as drainage, nephropexy, and decapsulation, as suggested by von Lichtenberg,

did not meet with much success in a series of 11 patients operated on at The Mayo Clinic.

#### SUMMARY

Since pyelonephritis is usually secondary to infection in the lower portion of the urinary tract, treatment must be directed to this source in order to prevent recurrence.

A working knowledge of urological bacteriology is essential to the intelligent treatment of urinary infection, since some bacteria respond better to certain drugs than to others.

Elimination of pus from the urine and cessation of symptoms do not necessarily mean that infection is completely eliminated. Repeated cultures must be made subsequently to insure recovery.

Recent developments in chemotherapy have given us two compounds which are much more efficacious in the treatment of infection in the urinary tract than any other drug previously employed and often give miraculous results. They are sulfanilamide (and its related drug, prontosil) and mandelic acid. Sulfanilamide compounds should be used more frequently as a preventive of infection such as occurs with post-operative retention of urine. Its bactericidal influence in small doses is employed for this purpose and in other types of urinary infection.

With the increasing efficacy of chemotherapy and the development of special vaccines, it may be predicted that primary pyelonephritis will be largely limited to its acute and subacute stages and that chronic pyelonephritis with its complications will develop only occasionally. This will, however, entail a thorough study of all the factors involved, including the bacterial, physiological and anatomical factors.

#### REFERENCES

1. DOMAGK, GERHARD. Ein Beitrag zur Chemotherapie der bakteriellen Infektionen. *Deutsche med Wchnschr*, 1935, 1: 250-253.
2. VON LICHTENBERG. Hydronephrosis. *Am J Surg*, 1929, 7: 747-752.

# SYMPATHECTOMY FOR THE RELIEF OF VESICAL SPASM AND PAIN RESULTING FROM INTRACTABLE BLADDER INFECTION

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**S**YMPATHECTOMY for the relief of pain in the urinary bladder was first performed by Piere in 1916. Since that time numerous authors have reported the results obtained from the employment of this procedure. A careful review of the literature devoted to this subject fails to reveal any unanimity of opinion regarding the indications for or the limitations upon this operation, and discloses a surprising variation in the end results of reported cases. During the past year several reports have appeared advocating various types of sympathectomy designed to relieve pain of bladder origin. It thus appears entirely proper that the subject be discussed critically in the hope that an understanding of the rationale of operation, its indications, and limitations might be evaluated. To that end a review of the literature pertinent to the subject is given and a critical analysis of the cases here reported is presented in an effort to shed further light upon this question.

The nervous anatomy of the bladder has been ably described by many exhaustive and complete reports. We will therefore, pass over the subject with but a brief mention of the essential pathways which comprise the innervation of the bladder and will present a résumé of its neurophysiology. The parasympathetic or sacral outflow arises from the anterior divisions of the second, third and fourth sacral nerves (Fig. 1). These trunks pass medially in the lower pelvis to the inferior hypogastric ganglia situated on each side of the rectum and beneath the bladder and here join the sympathetic or thoracolumbar outflow. Mixed fibers from both systems then supply the various parts of the bladder.

The sacral or parasympathetic outflow carries both sensory and motor components and supplies all the necessary reflex pathways for normal micturition. Many observers have pointed out that the sympathectomized bladder not only functions normally in so far as micturition is concerned but

also has normal tactile, thermal and pain sense. Denny Brown refers to such a case in which complete sympathectomy was performed for megacolon. This patient showed no discernible alteration in urinary function. Our sympathectomized patients here reported, all showed normal sensations to touch, heat, cold, and to painful stimuli in all parts of the bladder. Interruption of the sacral (parasympathetic) pathways produces an autonomic bladder the function of which is independent of voluntary control. Dribbling incontinence with residual urine is the rule, although this bladder may develop some degree of autonomic periodic emptying. Such a bladder innervated solely by the sympathetics is insensitive to heat and cold, and sensation of filling is essentially abolished although this is present in some. Pain sense is inconstant in this type of bladder.

The sympathetic or thoracolumbar outflow reaches the bladder by two routes. The route is first the presacral or hypogastric nerves which course downward in front of the sacrum as a single, or many branched nerve or, as is generally the case as a plexus of interlacing nerve fibers termed the superior hypogastric plexus. In the region of the hollow of the sacrum these fibers divide into two trunks termed the inferior hypogastric nerves and enter the inferior hypogastric ganglia where they are joined by the parasympathetic outflow. The second source of sympathetic fibers is two branches which arise from the lateral sacral sympathetic gangliated chain and also enter the inferior hypogastric ganglia.

The exact function of the sympathetic or thoracolumbar outflow is still open to debate. However, most observers agree that impulses carried by these pathways importantly regulate the tonicity of the so called internal sphincter of the bladder, the trigone of the bladder and the ureterovesical orifices. They also regulate contraction of the prostate, seminal vesicles, and ejaculatory ducts.

Vasoconstriction of the blood vessels over the trigone area has been reported by some observers, who have further noted a vasodilatation of this

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area following sympathectomy. Whether or not pain sensations are conducted over these trunks is, we feel, open to debate. Denny-Brown, Learmonth, and others have expressed the affirmative view regarding this function. Neuro-anatomists agree that somatic fibers, inconstant in number, are to be found in the hypogastric nerve bundles, accompanying the purely autonomic non-myelinated fibers. While it is accepted that these fibers may represent afferent (sensory) components, it has not been definitely established that such is the case. Surely experimental and clinical evidence does not fully support or contradict the point.

Learmonth reported having stimulated the proximal cut end of the presacral nerve during operation. His patient complained of a crushing or spasmodic pain in the region of the bladder. On the basis of this observation he concluded that the presacral nerve contained afferent components and expressed the belief that sensations of bladder spasm were conducted by these nerves. Denny-Brown had the opportunity of studying a patient who had a cauda equina lesion with complete destruction of the fourth and fifth lumbar vertebrae, and all of the sacral roots. He was thought to have his sympathetics intact because he could sweat. This patient could perceive pain in his bladder. In these 2 instances it is evident that sensory components accompanied the hypogastric nerves. Riddock has also presented evidence to show that the hypogastric nerves conduct painful impulses.

Our own observations in a small series, provided contrary evidence to that quoted above.

An illustrative case (Chart I) showed destruction of the parasympathetic pathways. That the patient's sympathetics were intact was revealed by the fact that he was able to ejaculate normally and that he had a tonic internal sphincter. Electrical stimulation to all parts of his bladder failed to elicit the sensation of pain, and heat and cold sensations were likewise lacking. It is to be noted that he did have sensation of bladder distention, however. An attempt was made to induce pain from bladder spasm in this case since some authors have accredited this function to the presacral nerve. One hundred cubic centimeters of a 2 per cent unbuffered mandelic acid solution was introduced into the bladder. This solution had previously been quite accidentally introduced into a normal bladder producing spasm with paroxysms of pain and was found to produce no lasting damage to the bladder. The mandelic acid solution was introduced in this instance through a catheter, using a burette for a reservoir. Although this autonomic bladder went into spasm, as shown by the fact that the solution was immediately forcibly expelled out through the end of the burette, the patient suffered no discomfort and was, in fact, aware of no sensation whatever.

Identical observations have been made upon 2 other cases presenting similar cauda equina lesions. From these studies we feel justified in con-

cluding that the hypogastric nerves may carry no afferent sensory components although in cases reported by other observers the contrary appears to be true.

This brief résumé of the bladder neurophysiology points out two essential facts pertinent to the discussion: first, that the parasympathetic pathways carry a constant and abundant supply of sensory components, and second, that the sympathetic pathways may or may not carry sensory components. It is further evident that sectioning of the sympathetic pathways alone does not interrupt the normal perception of pain in the bladder.

Complete sensory denervation of the urinary bladder has been accomplished by excision of the inferior hypogastric ganglia and by cordotomy. Removal of the inferior hypogastric ganglia was first performed by Rochet and reported in 1921. This was done for the relief of painful, tuberculous cystitis but was found to be an extremely hazardous procedure and carried the disadvantage of producing urinary incontinence. Learmonth reported that he performed this procedure for relief of pain resulting from malignancy but felt that the hazards of operation overbalanced the advantages of it. Cordotomy, occasionally resorted to for relief of bladder pain resulting from advanced malignancy, achieves this end with a minimum of risk and operative trauma. It presents the disadvantage of producing disturbances in urinary function with incontinence, but this objection should not contra-indicate its use in relieving the agonies of hopeless cancer.

Three techniques of sympathectomy have been described for the relief of bladder pain. The first operation of Piere, in 1926, consisted of simple resection of the presacral nerves (hypogastric plexus) which he performed for intractable cystitis. This operation did not provide complete relief of pain. Later, in 1930, he described a more extensive sympathectomy (Fig 2), including division of both paravertebral sympathetic chains at the lower border of the fifth lumbar vertebra and section of the gray rami from the first, second, and third sacral ganglia to their corresponding nerves. It was felt that this procedure would interrupt more sensory pathways than presacral neurectomy alone. The third technique, a simplification of Piere's second, was recently described by Scott and Schroeder. This method consists of performing presacral neurectomy and interrupting the lateral sacral sympathetic ganglionic chain by means of exeresis.

Practical experience has not demonstrated that the complete operation is more advantageous than



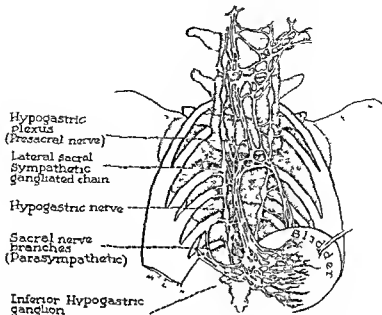


Fig 1 Schematic view of nerve supply of the bladder After Mueller *Lebensnerven und Lebensreise*

simple presacral neurectomy Learmonth concluded that relief of pain was obtained as effectively by the simpler procedure as by the more extensive one. Our own experience has borne out this observation.

A review of the cases reported in the literature disclosed that in the aggregate about 50 per cent of patients sympathetomized for bladder pain had, in reality, been relieved of their pain. For the purposes of critical analysis and evaluation, it is unfortunate that practically none of the reports disclosed the types of pain for which operation was performed or what types of pain were found to be relieved. The manner in which certain types of bladder pain are relieved by sympathetomy is we believe demonstrated by an analysis of the cases herewith presented.

#### CASE HISTORIES

**CASE 1** A. M. No 160733 a 43 year old housewife had chronic pyelonephritis intractable cystitis with mixed non tuberculous infection for 9 years which was resistant to all forms of therapy. The symptoms were frequency rate of 15 to 30 minutes day and night burning and severe spasmodic pain at every urination which was relieved only by narcotics for 2 years and 20 to 30 cubic centimeters were voided at each urination. The cystoscopic examination given by means of spinal anesthesia revealed a bladder capacity of 30 cubic centimeters and diffuse inflammation of bladder mucosa pyelograms showed hydronephrosis and hydro-ureter grade 2. A presacral

neurectomy was performed. Immediately after operation there was no spasmodic pain the patient voided every 30 to 60 minutes with burning in the urethra and the amounts varied from 30 to 100 cubic centimeters. Two months after the operation the patient voided about 30 to 100 cubic centimeters every hour with slight burning. There was occasional slight incontinence. A second cystoscopic examination given by local anesthesia showed the following: bladder mucosa normal throughout normal sensations in bladder pain on overdistention of the bladder and infection greatly reduced. Ten months post operatively there was no bladder pain voids up to 150 cubic centimeters every 2 to 3 hours with only slight urethral burning. The cystoscope used by means of local anesthesia at that time revealed a normal mucosa normal bladder sensations pain on overdistention of the bladder and a very slight amount of infection.

The patient has experienced some improvement in frequency and bladder capacity and complete relief from the intolerable paroxysms of spasmodic pain which had incapacitated her. She is entirely satisfied with the improvement of her status and has used no morphine since her operation.

**CASE 2** J. G. No 59365 a male farmer aged 25 years had Hunner ulcers of the bladder with moderate intractable bacillary infection of the bladder for 8 years which was resistant to all forms of therapy. There was no prostatic infection. The symptoms were frequency of urination every 1 to 2 hours by day and 4 or 5 times during the night burning on urination pain when bladder filled severe spasmodic pain on urination and voids amounting to from 90 to 150 cubic centimeters. Cystoscopic examina-

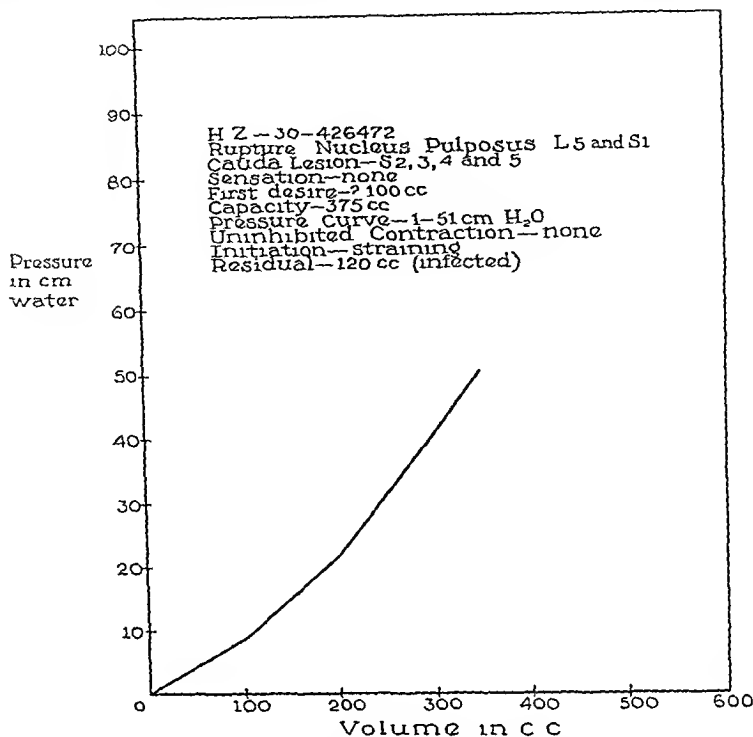


Chart 1 The autonomous neurogenic bladder. Rupture nucleus pulposus April, 1938, with pain in back and saddle anesthesia. June, 1938, developed practically total urinary retention with slight overflow incontinence, catheterized intermittently. There was bowel incontinence. Patient seen in University Hospital on July 11, 1938, with neurological findings of lesion of second, third, fourth, and fifth sacral cord segments with sensory loss only. Cystometric study July 11, 1938, demonstrated autonomous neurogenic bladder. Laminectomy and excision of ruptured intervertebral discs of fifth lumbar and first sacral on July 19, 1938. Cystometric studies August 1, August 16, and September 27, 1938, show autonomous bladder. Patient voids only with straining, overflow incontinence at night, controlled by Credé every 2 hours during the day. Sensations of heat, cold, tactile, and electric stimulation are absent, first desire and filling diminished or absent. Ejaculation, erection, and tonus of internal vesical sphincter are preserved. There is no pain on inducing bladder spasm.

tion, made with spinal anesthesia, showed a bladder capacity of 150 cubic centimeters, several typical Hunner ulcer lesions in the bladder, and hemorrhage on overdistention. Pyelograms revealed the right side to be normal and on the left side a slight hydronephrosis. A presacral neurectomy and exeresis of the lateral sacral sympathetics were performed. Immediately after the operation there was urinary retention with severe pain. This was relieved by an indwelling catheter drainage for 10 days followed by frequency every 15 to 30 minutes with severe burning in the urethra which subsided in 1 week. The patient was discharged on the forty-second day, voiding amounts from 100 to 150 cubic centimeters with complete comfort. Four months later voids continued to amount to 100 to 150 cubic centimeters with complete comfort. There was slight bladder pain on overdistention but urine was normal. Cystoscopic examination still showed active lesions of the Hunner ulcers, but there were normal sensations throughout the bladder to various stimuli. Ten months

after operation he voided normally, without pain, and output amounted to 150 to 175 cubic centimeters. The patient wrote "Am riding tractor every day and am grateful to be relieved of those awful spasms I used to have."

CASE 3 A S, No 413118, a housewife, 34 years of age, had Hunner ulcers of the bladder, chronic pyelonephritis with mixed infection which was resistant to all forms of therapy. This condition had existed for 3 years. The symptoms were frequency every hour, day and night, dull aching pain on bladder distention, severe paroxysms of spasmodic pain on urination, and voids of 60 to 90 cubic centimeters. The cystoscopic examination, made with spinal anesthesia, revealed a bladder capacity of 90 cubic centimeters, diffuse inflammation of the bladder mucosa, and several typical Hunner ulcers which bled on overdistention of the bladder. Pyelograms showed typical changes of chronic pyelonephritis with clubbing of calyces and definite narrowing of the infundibula. A presacral neurectomy and exeresis of the lateral sacral sympathetics

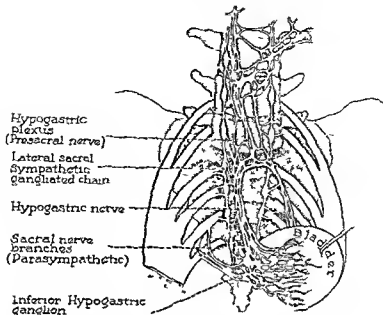


Fig. 1 Schematic view of nerve supply of the bladder After Mueller *Lebensnerv und Lebensstrasse*

simple presacral neurectomy. Learmonth concluded that relief of pain was obtained as effectively by the simpler procedure as by the more extensive one. Our own experience has borne out this observation.

A review of the cases reported in the literature disclosed that in the aggregate about 50 per cent of patients sympathetomized for bladder pain had, in reality, been relieved of their pain. For the purposes of critical analysis and evaluation, it is unfortunate that practically none of the reports disclosed the types of pain for which operation was performed or what types of pain were found to be relieved. The manner in which certain types of bladder pain are relieved by sympathetomy is, we believe, demonstrated by an analysis of the cases herewith presented.

#### CASE HISTORIES

**CASE 1.** A. M. No. 26033, a 43 year old housewife had chronic pyelonephritis intractable cystitis with mixed non tuberculous infection for 9 years which was resistant to all forms of therapy. The symptoms were frequency rate of 15 to 30 minutes day and night, burning and severe spasmodic pain at every urination which was relieved only by narcotics for 2 years, and 10 to 30 cubic centimeters were voided at each urination. The cystoscopic examination given by means of spinal anesthesia revealed a bladder capacity of 30 cubic centimeters and diffuse inflammation of bladder mucosa. Pyelograms showed hydronephrosis and hydro-ureter grade 2. A presacral

neurectomy was performed. Immediately after operation there was no spasmodic pain, the patient voided every 30 to 60 minutes with burning in the urethra and the amounts varied from 30 to 100 cubic centimeters. Two months after the operation the patient voided about 50 to 100 cubic centimeters every hour with slight burning. There was occasional slight incontinence. A second cystoscopic examination given by local anesthesia showed the following: bladder mucosa normal throughout, normal sensations in bladder, pain on overdistention of the bladder and infection greatly reduced. Ten months post-operatively there was no bladder pain, voids up to 150 cubic centimeters every 1 to 2 hours with only slight urethral burning. The cystoscope used by means of local anesthesia at that time revealed a normal mucosa, normal bladder sensations, pain on overdistention of the bladder and a very light amount of infection.

The patient has experienced some improvement in frequency and bladder capacity, and complete relief from the intolerable paroxysms of spasmodic pain which had incapacitated her. She is entirely satisfied with the improvement of her status and has used no morphine since her operation.

**CASE 2.** J. G. No. 30306, a male farmer aged 35 years had Hunter ulcers of the bladder with moderate intractable bacillary infection of the bladder for 8 years which was resistant to all forms of therapy. There was no prostatic infection. The symptoms were frequency of urination every 1 to 2 hours by day and 4 or 5 times during the night, burning on urination, pain when bladder filled, severe spasmodic pain on urination and voids amounting to from 90 to 150 cubic centimeters. Cystoscopic examina-

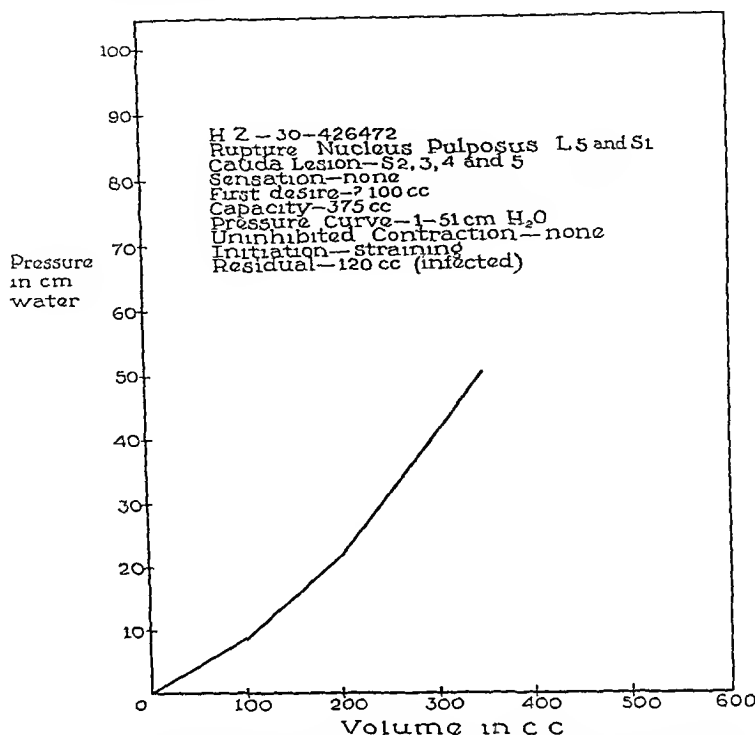


Chart 1 The autonomous neurogenic bladder Rupture nucleus pulposus April, 1938, with pain in back and saddle anesthesia June, 1938, developed practically total urinary retention with slight overflow incontinence, catheterized intermittently There was bowel incontinence Patient seen in University Hospital on July 11, 1938, with neurological findings of lesion of second, third, fourth, and fifth sacral cord segments with sensory loss only Cystometric study July 11, 1938, demonstrated autonomous neurogenic bladder Laminectomy and excision of ruptured intervertebral discs of fifth lumbar and first sacral on July 19, 1938 Cystometric studies August 1, August 16, and September 27, 1938, show autonomous bladder Patient voids only with straining, overflow incontinence at night, controlled by Credé every 2 hours during the day Sensations of heat, cold, tactile, and electric stimulation are absent, first desire and filling diminished or absent Ejaculation, erection, and tonus of internal vesical sphincter are preserved There is no pain on inducing bladder spasm

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CASE 3 A S, No 413118, a housewife, 34 years of age, had Hunner ulcers of the bladder, chronic pyelonephritis with mixed infection which was resistant to all forms of therapy This condition had existed for 3 years The symptoms were frequency every hour, day and night, dull aching pain on bladder distention, severe paroxysms of spasmodic pain on urination, and voids of 60 to 90 cubic centimeters The cystoscopic examination, made with spinal anesthesia, revealed a bladder capacity of 90 cubic centimeters, diffuse inflammation of the bladder mucosa, and several typical Hunner ulcers which bled on overdistention of the bladder. Pyelograms showed typical changes of chronic pyelonephritis with clubbing of calyces and definite narrowing of the infundibula A presacral neurectomy and exeresis of the lateral sacral sympathetics

were performed. The patient voided normally without incontinence immediately after the operation and was free from bladder spasm or pain. Voids amounted to 100 and 150 cubic centimeters. She was discharged on the seventeenth postoperative day. Four months later the patient voided up to 150 cubic centimeters once an hour during the day and 4 or 5 times during the night. There was no spasmodic pain on urination and no incontinence but she had mild dull pain in bladder on distention. A cystoscopic examination with local anesthesia revealed the Hunner ulcers to be unchanged. Eleven months after operation the patient had been free from severe pain; there was some bladder discomfort consisting of dull burning pain when bladder was distended or when she was fatigued. Frequency of urination without incontinence was each hour by day and 3 to 5 times during the night; voided 30 to 120 cubic centimeters. The patient stated that her bladder capacity was clearly limited by the discomfort of distention. The cystoscope revealed the Hunner ulcers to be unchanged; severe pain on distention of the bladder but normal sensations throughout the bladder to various stimuli.

With this patient there was complete relief from severe spasmodic pain, no improvement in frequency or discomfort on distention of bladder, slight increase in bladder capacity, and no change or improvement in Hunner ulcers, but she was completely satisfied and grateful for her operative result.

**CASE 4. B. B. No. 413883** a housewife 36 years of age had Hunner ulcers of the bladder with moderate intractable staphylococcal infection of both kidneys resisting all forms of therapy for 1 year. Urination had occurred every 15 to 30 minutes for 3 to 4 months. The patient slept on a bed pan and had intolerable bladder spasms on moving about and on urination. Spinal anesthesia was administered for the cystoscopic examination which revealed a bladder capacity of 60 cubic centimeters and a bladder highly inflamed throughout with several areas of ulceration. The pyelograms showed bilateral hydronephrosis and a one plus hydroureter. A presacral neurectomy with exeresis of the lateral sacral sympathetic chains was performed. Immediately after the operation the patient voided normally without any discomfort amounts ranging from 50 to 60 cubic centimeters for the first week. The capacity for the second week increased from 150 to 300 cubic centimeters with freedom from pain. She was discharged on the twenty first day voiding from 180 to 200 cubic centimeters without discomfort. Two months later she voided from 100 to 250 cubic centimeters with complete absence of bladder spasm but had slight burning in the urethra and had pain on overdistention of the bladder. A cystoscopic examination made with local anesthesia showed 3 typical Hunner ulcer lesions in the bladder but urine was normal. Eleven months after operation she voided every 2 or 3 hours with slight terminal burning in the urethra; she had no spasm and no pain in the bladder. She had slight urinary incontinence at times with loss of a few drops of urine and wore a napkin to prevent soiling her clothes. A cystoscopic examination revealed a bladder capacity of 180 cubic centimeters; overdistention produced severe pain; the bladder was normal throughout except for the Hunner ulcer areas which showed no change; bladder sensations were entirely normal.

With this case there was improvement but no cure of frequency; there was complete relief of

spasmodic pain which incapacitated the patient. She still had Hunner ulcers and had acquired a slight urinary incontinence, but was completely satisfied with the operative result.

**CASE 5. M. S. No. 399155** a housewife 25 years of age had tuberculous cystitis persisting for 5 years without relief following nephrectomy for renal tuberculosis. The symptoms were frequent urination every 30 to 60 minutes by day and 5 to 8 times at night with burning and severe bladder spasms and pain on each urination. General anesthesia was administered for the cystoscopic examination which revealed a diffusely inflamed bladder, a bladder capacity of 75 cubic centimeters, left kidney urine normal, pyelogram normal but bladder urine contained pus and tubercle bacilli. A presacral sympathectomy and lateral sacral sympathetics exeresis were performed. Immediately there was the normal desire to void and complete continence with no pain. By the tenth postoperative day the patient was voiding 100 to 150 cubic centimeters. She was discharged on the sixteenth day having no pain but moderate urethral burning on urination. During the night she voided about 1 or 2 times. Three months later she returned for a check up. She had been asymptomatic till a few days before when she developed increased frequency and urethral burning but no pain. The urine was found to contain many *Bacillus coli*. The patient was given a course of sulfanilamide with a regression of the frequency. Four months after operation the patient reported that she had continued free from her symptoms.

This patient had been relieved materially of her urinary frequency. Her capacity had considerably increased and she had remained entirely free from her spasmodic bladder pain.

**CASE 6. C. W. No. 374541** male a 45 year old laborer had tuberculous cystitis for 2 years following nephrectomy for right renal tuberculosis. He had had bladder irritation for 7 years prior to nephrectomy. He had a frequency of 1 to 2 hours during the day and night with spasms of pain on urination. Tubercle bacilli were found in the urine. Cystoscopic examination was made with general anesthesia revealing a diffuse ulcerative cystitis and a bladder capacity of 110 cubic centimeters. A presacral neurectomy was performed. Immediately afterwards he voided normally without incontinence. Frequency and capacity remained unchanged over pre operative state. There was no pain on urination. Four months later there was no increase in bladder capacity or frequency; patient voiding with complete absence of bladder pain or spasms but there was some burning in the urethra. Seven months after operation his general condition was excellent. He was continent; his urine was 4 plus pus and tubercle bacilli and he voided every 2 hours day and night with complete comfort.

This patient had not been relieved of his urinary frequency but has been made completely comfortable.

Analysis of these cases reveals certain constant factors. Prior to operation all had severe spasmodic bladder pain; all had some degree of difficulty in voiding although none had residual urine; all patients required general anesthesia for cystoscopic examination and cystometric examinations; in all instances revealed definite hypertonicity of the detrusor mechanism.

Following operation all patients were completely relieved of bladder spasm with its associated excruciating pain. In no instance has this spasmodic pain returned. All patients voided with ease following operation and 1 of the 4 female patients had slight urinary incontinence. Postoperative cystoscopic examinations were made in all cases under local anesthesia. All patients showed some residual bladder lesion and complained of pain on forcible distention of the bladder. Whether or not vascular spasm existed prior to operation and was relieved by it, was not discernible in this series. All patients showed an increase in bladder capacity immediately following operation. This increase in bladder capacity had persisted in 2 patients, while in 4 it had reverted toward the pre-operative level. None of these patients had been relieved of abnormal urinary frequency. None of the 3 patients with Hunner ulcers showed improvement of that lesion or relief from the discomfort usually associated with bladder distention in that disease.

All of the patients here reported are satisfied and grateful for the relief of their intolerable pain in spite of the fact that none can be considered as cured by the operation.

#### SUMMARY AND CONCLUSION

From the facts here presented it seems evident that sympathectomy relieves bladder pain, not by removing the essential afferent pathways from that viscus but by relieving spasm of the internal sphincter and perhaps other parts of the bladder musculature. Certainly the one constant and predominating feature of all the cases of this series was vesical spasm prior to operation. Likewise the one constant postoperative result was relief from intolerable spasm and ease of urination. These observations and conclusions completely bear out those of Douglas and the theories expressed by others.

It further appears evident that sectioning of the hypogastric nerves alone, without the more extensive and hazardous division of the lateral sacral sympathetics provides adequate relaxation of the sphincter to relieve bladder spasm.

Since normal afferent components exist in the bladder following sympathectomy, it appears illogical to suppose that bladder pain resulting from malignancy should be relieved by this operation.

In conclusion we would repeat.

- 1 The parasympathetic (sacral) pathways carry the essential afferent components of the bladder.
- 2 The sympathetic (presacral, or hypogastric nerves) pathways may or may not carry afferent pain components of the bladder.

- 3 Division of the presacral nerves provides relief of vesical spasm and pain resulting from intractable bladder infections.

- 4 Division of the lateral sacral sympathetics in addition to the presacral nerves accomplishes this same end but does not appear to be necessary or desirable.

- 5 Sympathectomy brings about the relief of spasmodic pain by relaxation of the vesical outlet and the detrusor mechanism, it does not render the bladder insensitive to pain of other origin.

- 6 Sympathectomy for the relief of bladder pain should be resorted to in only those patients in whom that pain is clearly demonstrated to result from spasm of the vesical outlet.

- 7 Sympathectomy was not shown to cure the lesions of Hunner ulcer in the cases here reported.

#### BIBLIOGRAPHY

- 1 BRAASCH, W. F. Spastic irritable bladder controlled by sympathectomy. *Proc Staff Meet Mayo Clin*, 1934, 393, 9-27.
- 2 CHAUVIN, E. Resection of presacral nerve in rebellious cystitis. *J Urol*, 1930, 30, 201.
- 3 CHEETHAM, J. C. Presacral neurectomy for relief of certain types of bladder dysfunction and pain. *J Urol*, 1937, 148, 37-1.
- 4 Idem. Presacral nerve resection for relief of bladder dysfunction and pain. *West J Surg*, 1938, 45, 260-266.
- 5 COTTE, G. Resection du sympathique pelvien. *Gynec et obst*, 1931, 23, 233.
- 6 Idem. Resection du nerf presacre pour dysmenorrhoea et cystalgia. *Lyon Chir*, 1932, 29, 616.
- 7 CRAIG, W. M. Discussion of presentation by Braasch, W. F. *Proc Staff Meet Mayo Clin*, 1934, 396, 9-27.
- 8 CUMMING, R. E., and SCHROEDER, C. F. The neuro-surgical treatment of bladder pain. To appear in early issue of *J Am M Ass*, 1939.
- 9 DAVIS, A. A. The surgical anatomy of the presacral nerve. *J Obst & Gynec Brit Emp*, 1934, 41, 942-952.
- 10 Idem. The presacral nerve—its anatomy, physiology, pathology, and surgery. *Brit M J*, 1934, 2, 1.
- 11 DENNY-BROWN, D. E. Nervous disturbances of the vesical sphincter. *New England J Med*, 1936, 215, 15, 647-664.
- 12 DOUGLAS, H. L. Excision of the superior hypogastric plexus in intractable cystitis, report of 5 cases. *Am J Surg*, 1934, 25, 249-253.
- 13 Idem. Indications for excision of the superior hypogastric plexus in disfunction of the bladder. *South Surgeon*, 1934, 3, 148-156.
- 14 ELAUT, L. The surgical anatomy of the so called presacral nerve. *Surg, Gynec & Obst*, 1932, 55, 581-589.
- 15 FULCHER, O. H. Presacral neurectomy for certain vesical conditions. *West Virginia M J*, Wheeling, 1935, 31, 465.
- 16 GRANT, F. C. The surgery of the autonomic system of the urinary tract. *J Urol*, 1936, 36, 261.
- 17 GRUBER, C. M. The autonomic innervation of the genito-urinary system. *Phys Rev*, 1933, 13, 497.

were performed. The patient voided normally without incontinence immediately after the operation and was free from bladder spasm or pain. Voids amounted to 100 and 150 cubic centimeters. She was discharged on the seventeenth postoperative day. Four months later the patient voided 40 to 150 cubic centimeters once an hour during the day and 4 or 5 times during the night. There was no spasmodic pain on urination and no incontinence, but she had mild dull pain in bladder on distention. A cystoscopic examination with local anesthesia revealed the Hunner ulcers to be unchanged. Eleven months after operation the patient had been free from severe pain. There was some bladder discomfort consisting of dull burning pain when bladder was distended or when the voiding frequency of urination without incontinence was each hour by day and 3 to 5 times during the night. voided 30 to 150 cubic centimeters. The patient stated that her bladder capacity was clearly limited by the discomfort of distention. The cystoscope revealed the Hunner ulcers to be unchanged. Severe pain on distention of the bladder but normal sensations throughout the bladder to various stimuli.

With this patient there was complete relief from severe spasmodic pain, no improvement in frequency or discomfort on distention of bladder, slight increase in bladder capacity, and no change or improvement in Hunner ulcers, but she was completely satisfied and grateful for her operative result.

CASE 4. B. B. No. 41335, a housewife, 36 years of age, had Hunner ulcers of the bladder with moderate intratubercular staphylococcal infection of both kidneys requiring all forms of therapy for 1 year. Urination had occurred every 15 to 30 minutes for 3 to 4 months. The patient slept on a bed pan and had intolerable bladder spasms on moving about and on urination. Spinal anesthesia was administered for the cystoscopic examination which revealed a bladder capacity of 60 cubic centimeters and a bladder highly inflamed throughout with several areas of ulceration. The pyelograms showed bilateral hydronephrosis and a one plus hydroneur. A presacral neurectomy with excision of the lateral sacral sympathetic chains was performed. Immediately after the operation the patient voided normally without any discomfort. Amounts ranging from 50 to 60 cubic centimeters for the first week. The capacity for the second week increased from 150 to 300 cubic centimeters with freedom from pain. She was discharged on the twenty-first day voiding from 150 to 200 cubic centimeters without discomfort. Two months later she voided from 100 to 250 cubic centimeters with complete absence of bladder spasm but had slight burning in the urethra and had pain on overdistention of the bladder. A cystoscopic examination made with local anesthesia showed 3 typical Hunner ulcer lesions in the bladder but urine was normal. Eleven months after operation she voided every 2 or 3 hours with slight terminal burning in the urethra. She had no spasm and no pain in the bladder. She had slight urinary incontinence at times with loss of a few drops of urine and wore a napkin to prevent soiling her clothes. A cystoscopic examination revealed a bladder capacity of 180 cubic centimeters. Overdistention produced severe pain. The bladder was normal throughout except for the Hunner ulcer areas which showed no change. Bladder sensations were entirely normal.

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spasmodic pain which incapacitated the patient. She still had Hunner ulcers and had acquired a slight urinary incontinence, but was completely satisfied with the operative result.

CASE 5. M. B. No. 30955, a housewife, 25 years of age, had tuberculous cystitis persisting for 1 year without relief following nephrectomy for renal tuberculosis. The symptoms were frequent urination every 10 to 20 minutes by day and 5 to 8 times at night with burning and severe bladder spasms and pain on each urination. General anesthesia was administered for the cystoscopic examination which revealed a diffusely inflamed bladder, a bladder capacity of 75 cubic centimeters, left kidney urine normal, pyelogram normal, but bladder urine contained pus and tubercle bacilli. A presacral sympathectomy and lateral sacral sympathetics were performed. Immediately there was the normal desire to void and complete continence with no pain. By the tenth postoperative day the patient was voiding 100 to 150 cubic centimeters. She was discharged on the sixteenth day having no pain but moderate urethral burning on urination. During the night she voided about 1 or 2 times. Three months later she returned for a check up. She had been asymptomatic till a few days before when she developed increased frequency and urethral burning but no pain. The urine was found to contain many *Bacillus coli*. The patient was given a course of sulfanilamide with a regression of the frequency. Four months after operation the patient reported that she had continued free from her symptoms.

This patient had been relieved materially of her urinary frequency. Her capacity had considerably increased and she had remained entirely free from her spasmodic bladder pains.

CASE 6. C. W. No. 37461, male, 41 years old, laborer, had tuberculous cystitis for 1 year following nephrectomy for right renal tuberculosis. He had had bladder irritation for 5 years prior to nephrectomy. He had a frequency of 1 to 2 hours during the day and night with spasms of pain on urination. Tubercle bacilli were found in the urine. Cystoscopic examination was made with general anesthesia revealing a diffuse ulcerative cystitis and a bladder capacity of 110 cubic centimeters. A presacral neurectomy was performed. Immediately afterwards he voided normally without incontinence. Frequency and capacity remained unchanged over pre-operative state. There was no pain on urination. Four months later there was no increase in bladder capacity or frequency. Patient voiding with complete absence of bladder pain or spasms but there was some burning in the urethra. Seven months after operation his general condition was excellent. He was continent, his urine was a plus pus and tubercle bacilli and he voided every 2 hours day and night with complete comfort.

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tion there first occurs hypotony and hyperkinesis. With the continuation of a chronic, partial obstruction this compensating stage of urinary tract function passes shortly into the decompensating stage of hypotony with hypokinesis, which may finally end in complete atony. These stages may be diagnosed by intravenous urography.

So much for the dynamics of urinary transportation. What about renal function? In acute, complete obstruction, in which the urinary tract is hypertonic and hyperkinetic, there may be a reflex cessation of renal function. In these cases all our diagnostic functional methods would reveal no renal function, yet, if such obstruction be of short duration, renal function returns to normal. In chronic, long standing, partial obstructions, in which the urinary tract is in the decompensating stage of hypotony and hypokinesis, renal function is impaired; but no test has yet been devised to tell us the degree of permanent impairment. All functional tests merely measure renal function at the time the test is done. However, we know clinically how many times supposedly functionless kidneys have shown permanent improvement of function, sometimes to a very great degree, when the obstruction has been removed. We believe that there will always be some restoration of renal function if the renal parenchyma has not been entirely destroyed, provided there is not complete atony of the urinary tract. This can be determined by the response of the pelvis and ureter to faradic or other stimulation at the time of operation.

From the standpoint of renal function it is important to know whether the renal pelvis is intraparenchymal or extraparenchymal, for intraparenchymal dilatation will cause much greater pressure death of functioning renal tissue than if it is possible for the pelvis to dilate extraparenchymally. We will discuss later the rôle such intraparenchymal pelvic dilatation might play in hypertension. However, the extent to which an obstructive uropathy may be evaluated in terms of impaired urinary tract function depends upon an inherent system reserve, the factors of which are primarily (1) The ability of the kinetic factor to maintain normal emptying rate in hypotonic dilatation of the urinary tract, (2) the ability of kinetic recovery in cases of hypotony and hypokinesis after the mechanical obstruction is removed, or after the cause of an adynamic obstruction (infection) is eliminated, and (3) the ability of the renal pelvis to dilate extraparenchymally, in which case pressure destruction of the renal parenchyma will be minimized.

All are familiar with the various pathological processes which may cause obstruction in the upper urinary tract. If we consider the etiology of obstructive uropathies, we may classify all these processes into 2 main groups. The first group is that of *mechanical obstructions*, which is further subdivided into the intrinsic obstructions, such as stone, congenital stricture, etc., and the extrinsic obstructions, such as periureteritis, accessory blood vessels, ureteral kink, renal ptosis, etc. The second main group we have called the *adynamic obstructions*, which include congenital atonies, infectious atonies, usually due to lymphatic extension of infection from the adnexa, and idiopathic neuromuscular dysfunction.

The symptomatology of obstructive uropathy is indefinite. In the adynamic obstructions pain never occurs. In the mechanical obstructions typical colic-like pain occurs only if the renal pelvis or the ureter be suddenly distended. In the gradually acquired pathological states, however, there seems to be a decided tendency for sensory symptoms to be referred to the gastrointestinal tract, and to be given naturally a gastrointestinal interpretation.

Much could be written concerning the rôle of infection in obstructive uropathy. Extension of an infection from the adnexa through the periureteral lymphatics may produce an adynamic disturbance of urinary transportation. Infection within the urinary tract itself always hastens renal destruction. Most important, however, is that the persistence of infection is almost proof of existing obstruction to the free transportation of urine, whether this obstruction be of the mechanical or of the adynamic type. It is almost impossible to infect experimentally a normal urinary tract. Conversely, it is almost impossible to disinfect a poorly emptying urinary tract. One of our therapeutic axioms states that a urinary infection cannot be eradicated in cases of urinary stasis, even if renal function allows sufficient concentration of our urinary antiseptic at the site of the infection.

In closing, let us see what relation obstructive uropathy might have to hypertension. Goldblatt and his co-workers have shown that experimental hypertension in dogs may be produced by partially constricting one renal artery. Leadbetter and Burkland have recently reported a case of hypertension in a boy  $5\frac{1}{2}$  years of age, which was cured by removing a functionless kidney, the main artery of which was found to be almost completely occluded by a smooth muscle plug which reduced the lumen to a mere crescentic slit. Butler records 2 cases of hypertension associated



- 18 JABOULARY M. Le traitement de la névralgie pelvienne etc. Lyon méd 1899 90 102
- 19 LATARJET A and BOYVER J. Le plexus hypogastrique chez l'homme. Lyon chir 1913 0 611
- 20 LEARMONTH J R. A contribution to the neurophysiology of the urinary bladder in man. Brain 1931 54 147
- 21 Idem. Neurosurgery in the treatment of diseases of the urinary bladder. J Urol 1931 26 13
- 22 Idem. The value of neurosurgery in certain vesical conditions. J Am M Ass, 1932 98 632
- 23 LEARMONTH J R and BRAASCH W F. Resection of presacral nerve in diseases of the bladder. Tr Am Ass Genito-Urin. Surg, 1932 25 313
- 24 MCCONNELL A A. Vesical pain. Irish J M Sc, 1933 85 209-211
- 25 MCCREA E D and MACDONALD, A D. Presacral sympathectomy and the urinary bladder. Brit J Surg 1934 6 119-127
- 26 PEARL F L and STRAUSS B. Presacral neurectomy and sacral ganglionectomy in affections of the bladder. J Urol 1938 39 5 645
- 27 PIERRE G. L'ervation ou ramiscction. Presse méd 1916 34 1141
- 28 Idem. Contributs clinici. Arch ital di chir 1930 27 454
- 29 QUINBY W C. Resection of presacral nerve in painful bladder of interstitial cystitis. Tr Am Ass Genito-Urin Surg, 1931 24 355
- 30 RIMMOCK G. Conduction of sensory impulses from the bladder by the inferior hypogastrics. J Physiol, 1921 LIV 134 in Proc of the Physiol Soc of Feb 12 1921
- 31 ROCHET V. Traitement chirurgical des cystites douloureuses. Lyon chir 1911 18 461
- 32 SCOTT W J, MERLE and SCHROEDER CARLILE F. Denervation of the bladder for relief of intractable pain. Ann Surg 1938 108 730-741

## OBSTRUCTIVE UROPATHIES

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**I**N 1926 the term, obstructive uropathy was introduced into medicine by Young with the following definition: "Under this heading are grouped all the changes in the kidney, pelvis, ureter, bladder, and urethra resulting from obstruction to the free outflow of urine from the urinary tract." This definition epitomizes the urological interpretation of disease prior to the introduction of intravenous urography when we thought only in terms of organopathology and organphysiology. We were by then becoming familiar with the usual gross lesions of the urinary organs and as is always the case we were striving for a similar familiarity with the evidences of earlier pathological changes. But we still thought in terms of individual organopathology.

Since the advent of intravenous urography in 1930 we have learned to evaluate all urinary tract disease except renal neoplasms in terms of urinary tract function rather than in terms of the pathological end picture and for the first time we have been able to visualize competently the normal and the perverted physiological function and to picture and study the entire urinary system uninfluenced by any extraneous artifact. We should, therefore, revise our previous conception

of an obstructive uropathy by realizing that we are not interested so much in the static changes in the urinary organs "resulting from obstruction to the free outflow of urine" as in the *real changes*—changes in urinary tract function—which can be determined only through a physiological interpretation of the intravenous urogram. If urinary tract function has been affected by an obstructive uropathy we must differentiate between a derangement due principally to impaired renal function and a derangement due to deficient urinary transportation. These two factors though interdependent must be distinctly separated and individually analyzed.

In this paper we will confine ourselves entirely to the upper urinary tract. A brief consideration of the dynamics of the upper urinary tract will serve as an introduction.

When an obstructing lesion produces disturbance of urinary tract function resulting dilatation of the urinary tract is just an anatomical compensating factor. Important however is the kinetic or emptying factor. Renal function and urine transportation will not be impaired in the cases of dilatation if the kinetic function maintains a normal emptying rate. Any sudden mechanical obstruction, such as the impaction of a small stone in the ureter, results immediately in pelvic and ureteral hypertony and hyperkinesis i.e. a renal colic. In any chronic partial obstruc-

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# SYMPOSIUM: TREATMENT OF FRACTURES

## CONSERVATIVE TREATMENT OF FRACTURES

E. L. ELIASON, M.D., Sc D., F A.C.S., Philadelphia, Pennsylvania

**E**XAMINATION of the records of several local hospitals shows that from 10 to 15 per cent of patient visits are made for fracture treatment. Such a common condition probably exists uniformly in other communities and must of necessity be met and treated by a great number of physicians, not all surgeons by any means.

Fractures are, however, the pet aversion not only of the general practitioner but of many surgeons. The reason is twofold. The average physician will not take the time to equip himself with a thorough knowledge of fractures nor will he exercise the patience and the painstaking, time-consuming care necessary for a favorable outcome. Consequently the ultimate results in broken bones are not all that could be expected nor that we could desire. The same discontent is experienced by the patient and hence the frequency of suits for malpractice which is the second reason for the unpopularity of fracture cases in the eyes of the physician.

Thus dislike of fractures is made even greater by reason of the fact that we have run wild with invention and production of costly, strange, wondrous, and complicated gadgets with a multiplicity of levers, nuts, screws, weights, springs, etc., designed to fit fracture treatment into the machine age. Many of these puzzling contraptions are expensive and most of them are cumbersome and require a mechanic or engineer to assemble them. Our hospital storage spaces contain hundreds of dollars worth, bought for one surgeon, for one patient, employed once, often unsuccessfully, and discarded thereafter. In the hands of the originator a complicated apparatus may work wonders, but may cause only confusion and defeat in another. The man and not the splint is responsible for the result. Hippocrates said that the man who presumes to treat fractures must be equipped to do so under any conditions. Special splints for special fractures are desirable and often

necessary, yet the simpler methods of reduction and fixation that have stood the test of time will in the long run, in the greatest number of hands, in the greatest number of patients, produce the greatest number of good results.

Information on fracture treatment should, therefore, be conservative and simple enough in its application to be useful to the general practitioner, reserving the more complicated methods for the unusually difficult cases in the hands of men trained for such work.

Most of the principles of fracture treatment have come down to us from the centuries and a brief historical paragraph may be of interest. Magnuson, of Chicago, wrote a most interesting historical article upon this subject and I will not hesitate to quote some of his facts. Records of fracture treatment come to us from 4,500 years ago. Braestead and Smith, after examining about 5,000 mummies, found that about 5 per cent had fractures, many with splints in place. These fractures had been treated logically and gave excellent results even under our standards of today. Principles enumerated 2,500 years ago are sound to-day. These ancients spoke of "traction and counter traction, position of muscle balance, alinement regulated according to nature, early reduction, traction in the long axis, prevention of pressure points, elevation for swelling, and suiting the splint to the patient and not the reverse." Warning was given not to remove splints until union was solid and designation was made of the average time required for union in the various fractures. This knowledge was carried to Rome by the Greeks and in the first century A.D. Martial referred to Hermes as the best surgeon for fractures and remarked that there were many specialists, some for enlarged tonsils, some cutters for stones, some bone setters, blood letters, and some for removing brands from slaves.

Old as these tenets are, have we respected them as we should? Do we remember and practise them? Do we make use of our x-ray always as a blessing or do we make it into a curse and treat the film evidence rather than the broken bone in the patient? Has simplicity been replaced with

From Section "A" of the Surgical Clinic of the Hospital of the University of Pennsylvania

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with unilateral pyelonephritis in children whose blood pressure returned to normal after nephrectomy. Arteriolar changes were found in the removed kidneys. Freeman and Hartley have recently added another interesting case of hypertension associated with renal ischemia. We recently obtained a similar clinical result by removing a hypoplastic kidney with hypoplastic renal vessels from a young man 28 years of age. There is clinical evidence, the more so that renal ischemia in one kidney may produce hypertension in man just as it does experimentally in dogs.

But renal ischemia does not necessarily have to be caused by partial constriction of the renal artery. Hartwich, and Harrison and his co-workers have produced hypertension in dogs by ligation of one or both ureters. In man, however, hypotension is just as frequently associated with ureteral occlusion as hypertension. The renal pelvis in dogs is principally intraparenchymal, and dilatation can readily cause renal ischemia by parenchymal pressure. In man, due to the anatomical relationship of the pelvis to the parenchyma, dilatation is frequently almost entirely extraparenchymal. In these cases of course ureteral occlusion would not be as liable to produce renal ischemia. What percentage of cases of hypertension in obstructive uropathy

can be explained by a dilating intraparenchymal pelvis remains to be determined by further clinical investigation.

In conclusion, it may be stated that the rôle of obstructive uropathy broadens as we begin to appreciate and to interpret the finer and earlier diagnostic criteria and to correlate with this study a growing appreciation of the normal and the perverted physiology of urine transportation. The value of intravenous urography is without parallel and is indispensable in attaining this end.

#### BIBLIOGRAPHY

1. BUTLER A. M. Chronic pyelonephritis and arterial hypertension. *J Clin Invest.* 1937 16 839.
2. FREEMAN C. and HARTLEY G. JR. Hypertension in a patient with a solitary ischemic kidney. *J Am I Ass.* 1938 111 1159.
3. GOLDBLATT H. LYNN J. HANZAL R. and SCHWARTZ W. Studies on experimental hypertension. *J Exper Med.* 1934 59 347.
4. HARRISON T. MASON M. RESNIK H. and RAYNE J. Changes in blood pressure in relation to experimental renal insufficiency. *Tr Ass Am Physicians* 1936 51 280.
5. HARTWICH A. Die Beziehungen zwischen Niere und Blutdruck im Tierversiment. *Verhandl d deutsch Gesellsch f innere Med.* 1939 41 187.
6. LEADBETTER W. F. and BURKLAND C. E. Hypertension in unilateral renal disease. *J Urol.* 1934 39 611.

imum amount of trauma incident to the reduction. We are taught that certain muscles act to produce certain physiological movements and positions of parts. Additional observation under the fluoroscope, together with the aid of a conscious patient and local anesthesia, aids greatly in determining the full extent of these muscular actions. A fracture of the shaft of the forearm bones is the best example of this. Experience has shown that here the best position for reduction is with the elbow acutely flexed, and the forearm acutely supinated with traction exerted from over the shoulder of the affected side.

Trauma means destruction and increased hemorrhage, devitalization, and added difficulty due to muscle spasm and pain. Many times roughness has defeated the purpose.

*Thoroughness* If success is to be our reward, thoroughness is essential and yet it must not be overemphasized. A cabinet-maker's or perfect reduction does not insure a perfect function nor does the absence of perfect reduction necessarily indicate diminished function. It is here that individuality and judgment play such an important rôle. In the past there were only two parties concerned in a fracture result, the patient and the surgeon. A fair anatomical result, with fair or good function, satisfied both. When the roentgen-ray entered the field at once there was born the desire to obtain the so called roentgen or a cabinet-maker's reduction. This resulted in an associated increase in the number of open reductions. Next, a third party entered the field, namely, the insurance companies and our results are now scrutinized by this third party with an impartial eye.

In some respects this has been advantageous to the patient but in other respects it has led to the desire to obtain the so called perfect reduction. Why? It is due to the fact that a jury is more than likely to judge the result by the roentgenographic evidence and not by the degree of function obtained. Hence, we actually find that more open reductions are resorted to in an endeavor to meet this demand. Then, too, if the patient or his family view the film, which should always be insisted upon, they ask for open reduction thinking it necessary for a good result.

*Individuality* Life, limb, and function for each individual is necessary. Restoration of contour is desirable if compatible with these. A fracture is not only a broken bone but injured soft parts in addition. In fact the soft tissue damage, separately and collectively, may be, and often is, more important at the time of the accident and later when considered in the light of functional results. Perfect alignment, perfect reduction, minimum

deformity, etc., are desirable but not always necessary for restoration of function. It must be the aim of the surgeon to evaluate the numerous factors with relation to required results for the individual case and so conduct treatment. So varied may be the injuries associated with a broken bone, so numerous the constitutional factors incident to age, disease, site of fracture, function desired, economic conditions, etc., required for each particular case, that individuality rather than generality in treatment must obtain. Principles are comprehensive and abstract, but practice must be individual and concrete. Each patient and treatment must click. Fit the treatment to the patient and not the patient to the treatment.

A young person will obtain a better result than will an adult with the same original deformity, by reason of growth factors. A young tennis player will require better function in his forearm than will the retired banker of 70 years. A bad cardiac case might rather have malunion than an open reduction. A badly comminuted fracture of the femur merely requires length and alignment, not perfect reposition. An athlete will require length and alignment for a fracture of his leg. An elderly night watchman could put up with a limp. It is astonishing what vicious deformities may accompany excellent functional results in fractures in the upper extremity of the humerus for example when treated conservatively. Epiphyseal separations do not often require perfect reposition at the expense of an open reduction. Again our statistics show that open reduction in these latter cases is necessary in less than 3 per cent.

A surgeon treating fractures must be practical and must have a mechanical sense. He must be willing individually to at least supervise the treatment throughout the case. Treatment should be absolutely, entirely, and constantly under the guidance of one man.

The initial attempt at a reduction should be accompanied by every factor that could be desired to insure success, proper and sufficient assistance, complete relaxation anesthesia, fluoroscopic control, and the necessary armamentarium for traction and fixation as required. Repeated attempts at reduction militate against the best results, often terminating in open reduction. Our statistics show this relationship very definitely. At certain sites such repeated trauma may terminate in non-union. Ashhurst stated years ago that malunion of moderate degree is less evil than non-union.

When may accurate reduction be imperative? Although not always necessary the best restoration of contour may be required in fractures near or into a joint, in the mid shaft of the humerus,

complexity and multiplicity and the desire to do open reduction for a cabinet maker's reposition? And have we forgotten that the aim of all fracture treatment is the restoration of function with or without restoration of contour? Reported figures show that only 65 to 66 per cent of fractures with good reposition gave good function whereas 45 per cent with poor reposition gave good function. Evidently factors other than the position of the fragments are concerned. It is better to have a deformity with function than a perfect union with dysfunction that results in a reduction of the individual's earning power. The patient must have at least the function necessary for his livelihood.

The 4 factors of most importance in the treatment of any and all fractures are promptness, gentleness, thoroughness, and individuality, as stated by Dr. William Darrach many years ago.

**Promptness.** No patient suffering with a fracture of a long bone shaft should be moved until the best available fixation has been applied. The trauma of injudicious first aid treatment is often responsible for the bad results. Such careless and injudicious treatment is not always limited to the aid given by the laity, but is all too often met with after the patient reaches the hospital. A patient with a fracture of the shaft of a long bone transported without adequate splinting will have added vessel, muscle, and nerve injury. The limb should be placed as nearly as possible in the position of muscle equilibrium. In the case of the lower extremity, traction as nearly as possible in the direction of the long axis of the uncontrollable fragment is really a necessity. In the humerus the weight of the limb slung at the wrist together with chest binder will suffice if the patient is transported in the upright position. In fact, actual lengthening of the part is sometimes thus obtained. Needless to say if shock exists the appropriate treatment together with morphia should be instituted. Figures indicate that proper transportation splinting, together with large doses of morphia, reduced the mortality in compound fractures of the femur in the World War from 75 to 15 per cent.

The actual or definite treatment of the fracture should be undertaken just as soon as possible, the condition of the patient permitting. A very careful examination should be made with reference to possible visceral nerve or vascular injury before any manipulation is attempted. The original trauma causes nerve injuries quite often in certain fractures. 4 to 8 per cent in cases of fracture of the humerus, of 271 nerve injuries with fractures quoted by Lewis and Miller, 24 per cent were pri-

mary and 42 per cent secondary and incident to treatment. Such knowledge should serve to indicate the need for observation and prevention. Should such injuries be found the patient or members of his family should be informed of their serious nature. The earlier the reduction is attempted the easier its accomplishment. A properly reduced fracture becomes increasingly more comfortable. Persisting pain requires investigation.

It has been the writer's privilege to be present on the field and see many fractures occur in athletic pursuits. Immediate gentle traction and manipulation within a few seconds while the tissues were numb and the muscles relaxed resulted in a very high percentage of reductions sufficiently perfect as to require no further adjustment. Delay permits coagulation, fibrin formation, and cellular exudation with consequent loss of tissue elasticity. The blood at the fracture site soon loses its liquid state and becomes a fibrinous, gum like clotted mass, interfering with bone reposition and making it more difficult or even impossible. Such are the effects of delay. It is only fair to state that there are some who advocate delay for varying periods of time (days) before reduction is attempted. These advocates report good results. Adequate assistants, satisfactory anesthesia, local spinal or ether and, when possible, the fluoroscope are very desirable. It may be stated here that in acute fractures only a few hours old, no cocain injected around the fractured surfaces is most satisfactory in preventing pain and producing muscle relaxation during the reduction. Furthermore, the patient being conscious very often can cooperate splendidly.

Today as soon as a fracture patient is admitted to the University of Pennsylvania Hospital the interne on service examines him thoroughly for associated injuries, meanwhile notifying the chief or his assistant on service and they and the patient meet in the fluoroscopic room where the reduction is conducted. The interne is active in the reduction, being aided and supervised by his seniors. Only when he fails does the more experienced man take hold. This practice has increased the number of successful primary reductions from 45 to 80 per cent in a few years.

**Gentleness.** No fracture should be traumatized any more than necessary. Eliciting of crepitus is not necessary for diagnosis. It may be harmful. All movements affecting the fractured bone should be undertaken slowly and gently, gradually increasing traction in the direction of muscle equilibrium or balance. If care is exercised in obtaining this position of muscle equilibrium not only will the reduction be simple but there will be a mini-

mum amount of trauma incident to the reduction. We are taught that certain muscles act to produce certain physiological movements and positions of parts. Additional observation under the fluoroscope, together with the aid of a conscious patient and local anesthesia, aids greatly in determining the full extent of these muscular actions. A fracture of the shaft of the forearm bones is the best example of this. Experience has shown that here the best position for reduction is with the elbow acutely flexed, and the forearm acutely supinated with traction exerted from over the shoulder of the affected side.

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When may accurate reduction be imperative? Although not always necessary the best restoration of contour may be required in fractures near or into a joint, in the mid shaft of the humerus,

and in the forearm Length and alignment is very essential in all lower limb fractures

*Open reduction* Open reduction may be fraught with great danger of loss of function limb, or even life To teach the promiscuous employment of this method will bring sorrow to many in its application This refinement should be resorted to only after much deliberation If experience has shown that the type of fracture under consideration will heal with good function despite its displacement, let sleeping dogs lie and treat the fracture by the closed method

There are 3 indications for open reduction in an acute fracture, namely failure to obtain a satisfactory reduction by the closed method failure to maintain a satisfactory reduction and lastly, and probably the most important, the surgeon's ability to obtain a satisfactory result if he resorts to an open reduction In order to have a clear understanding we must explain what the term, satisfactory, should mean in each of the 3 instances Here, again individuality enters the field

The assurance of a satisfactory result if open reduction is to be undertaken is almost imperative We must base this assurance on the experience we have had in fracture surgery, the bone or bones involved and the level of the fractures in the same the condition of the patient's health, his age, the age of the fracture, and whether our efforts can accomplish a better functional, not necessarily a better anatomical result Extensive comminution as a rule should be a deterrent to open reduction

It is not the purpose of the writer to discuss the surgical technique of open reduction but I would like to emphasize one point Throughout the literature on the subject, emphasis is placed on keeping the gloved hands out of the wound Too much emphasis upon this detail has hampered many an operator to the detriment of the patient In reality there seems to be no reason why a fresh glove previously untouched should enter the wound with any more danger than an instrument The gloved finger inserted at the fracture site will inform the surgeon at once concerning the character and condition of the fractured area and the direction for extension of the incision if desirable and hence minimize the trauma that must of necessity follow, due to tissue injury by needlessly large misplaced incisions and retractions required to permit visualization

Here a word may well be added with regard to internal fixation in open reductions in general It has been the writer's practice in the past to use internal fixation (plate and screws preferably) only

when the fragments will not remain in their proper relationship with the limb placed in the muscle balanced position Adherence to this principle is responsible for the need for internal fixation in only 18.3 per cent of cases in which patients have been operated upon

The age of the fracture in poor position or with vicious union needs individual judgment, neither, invariably will mean poor function To attempt to break up a vicious position with  $2\frac{3}{4}$  inch shortening in a 14 weeks old fracture may be justified in a youngster but not in a hemiplegic or a patient with Buerger's disease

*Roentgenograms* Films showing 2 views should when feasible, be taken of every suspected fracture before an attempt is made to reduce it This both lessens the possibility of trauma and protects the surgeon against the accusation of injury influenced by his manipulation After the reduction of a fracture under an anesthetic the roentgenogram should not be taken until the anesthetic has ceased to act Many times a fracture will remain reduced with the muscles still under the anesthetic but the fragments will slip when the muscle tension has returned We had best be satisfied with the fluoroscopic evidence for that day and take a film 24 hours later A third film showing 2 views should be taken 2 weeks later

*Physical therapy* A fracture recovers best when the nutrition of the bone and those structures associated with it most nearly approach normal Physical therapy aids in restoration of blood supply It should begin if feasible, when the treatment of the fracture begins not after union has occurred

Return to full function of weight bearing, etc must be withheld until solid clinical union is found to be present The roentgenographic evidence with regard to the rigidity of callus cannot be depended upon

It has been our experience that the patient himself is his best physical therapist It should be explained to him that return to function is his job and that only by exercise supplemented by massage and heat, can he get well He should be carefully instructed in how to use all of these measures Aided active motion should be explained to him Pain is nature's warning of trouble He will not injure himself but a physical therapist might If a therapist is on the case at once, the patient transfers all responsibility to his shoulders, feeling that he only a patient does not know enough to conduct his own treatments The individual is his best physical therapist even without the various baths electrical rays lights currents and other such measures

It is not within the scope of this presentation to describe in detail the various efficient and yet simple dressings described by every treatise on this subject, but rather to call attention to the fact that the meticulous attention to the application of the simple fundamental principles of treatment will give the most satisfactory results, for the most patients, and the most physicians. Special intricate apparatus has its place in special conditions and in special hands.

#### RESULTS OBTAINED

Following the above principles of treatment our results have improved year by year. There has been an increase in the number of successful primary fluoroscopic reductions. Open reduction was necessary in only 7.3 per cent in the last 3 years of those cases serious enough to be admitted to the hospital. Metal, internal fixation material was necessary in only 18.3 per cent of cases. This reduction from the former figures of 33 per cent occurred very largely in forearm fractures, and open reduction results were good in 69.9 per cent, fair in 20.6 per cent, and poor in only 9.5 per cent.

#### CONCLUSIONS

1 A fracture implies soft tissue injury as well as a broken bone, and a fracture requires emergency treatment. Promptness is essential, the earlier reduction is attempted the easier reduction is accomplished.

2 Swelling should indicate action rather than delay, and the best way to reduce swelling is to reduce the fracture. Fluoroscopic control with local or spinal anesthesia is desirable. Position of muscle equilibrium reduces trauma and facilitates reduction.

3 Gentleness is indicated, thoroughness is essential but a cabinet-maker's reposition is not necessary to good function, and individuality is essential for best results. It is not the splint but the man behind it that produces results. Fit the treatment to the patient and not the patient to the treatment.

4 Deformity does not mean dysfunction, deformity with function is preferable to perfect restoration, but with loss of earning power. Function, necessary to the individual's livelihood, should be the goal.



## THE CINEPLASTIC AMPUTATION

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**A**MONG the large group of the disabled who seek the services of rehabilitation agencies, the amputation case is one that requires careful consideration. On the basis of the Cleveland survey, Faries has estimated the number of persons with arm amputations in the United States to be in the neighborhood of 33,000. While this appears to be a rather high estimate, it nevertheless calls attention to one serious type of handicapped patient whose rehabilitation becomes an important concern of all public agencies.

Many may rehabilitate themselves through educational or vocational aptitudes that are not affected by their handicap. Some have well adjusted personalities that make their social adjustment comparatively easy. The larger number, however, are unable to help themselves and therefore, seek our aid. Employment is facilitated by providing these individuals with artificial appliances. The prosthesis serves to remove the psychological aversion toward the crippled by replacing the missing member. It likewise offsets the

economic prejudice of the employer through the increase in industrial efficiency displayed by the amputee.

A man who wears an artificial leg is the least disabled of all cripples. Such a device not only substitutes for the weight bearing function of the natural leg but also eliminates the repellent attitude caused by the defect. Fitting an artificial leg is not a difficult task except in unusual situations.

On the other hand, the problems which face us in the fitting of an appliance to an arm stump are extremely difficult. In the case of an amputation of the arm or hand, the complete restoration of function by any mechanical means is quite beyond human invention. While it has been possible to imitate some of the simpler prehensile actions of the hand by jointed fingers, which can be flexed at will, this should not lead to an enthusiasm which is not warranted in fact and which raises only false hopes in the minds of the armless. The perfection of a mechanical hand with delicate selectivity has baffled inventive genius.

Only a small proportion of those supplied with artificial arms wears them and a still smaller proportion actually uses them. During the World

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a



b

c

Fig. 1. a. Traumatic amputation of both arms following trolley car accident; double motor in forearm and upper arm. (Courtesy of Drs. Goff and Vergason.) b. With prosthesis holding cup. c. Use of prosthesis in bringing cup to mouth.



Fig 2 Sixty-three year old lithographer In this patient a cineplastic operation had been performed 30 years after the original amputation Excellent muscle re-adaptation has been accomplished despite the long period of disuse

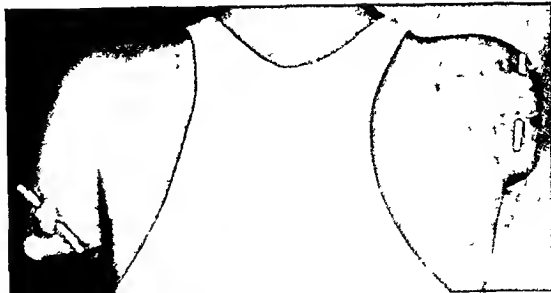


Fig 3



Fig 3a



Fig 3b



Fig 3c

Fig 3 High double-arm amputation following railroad accident Practically no stump remaining in the right arm Biceps and triceps muscles canalized in left arm and fixation canal prepared in right shoulder stump, a, front view with prosthesis showing peg through biceps canal, b, back view showing peg through triceps canal Hand mechanism on left arm activated by biceps and triceps motors On the right arm the elbow and hand mechanism is activated by cross straps on shoulders, c, showing patient fully dressed

War our government permitted the armless veterans to choose any artificial arm on the market Many chose complicated mechanical hands and arms which they soon laid aside as too cumbersome In England the results were also disappointing In 1918 the Ministry of Pensions made an inquiry into the use of arms furnished by the government and found that considerably less than half were using them In Germany a survey made over a long period of years among a group

of 7,000 arm amputations showed only 129, or 1.8 per cent, wore a mechanical arm (4) In a personal series of 1,500 arm amputations, 230 were observed over a period of 6 years At the end of this period only 12 per cent of this group were wearing their artificial arms and 6 per cent were using them for work and in the routine pursuits of life

The principal problem is that of making the stump play a supporting rôle in daily life and



Fig 4 Traumatic amputation of upper third of forearm following industrial accident with double motors, *a* at right with prosthesis note that apparatus does not extend above the elbow

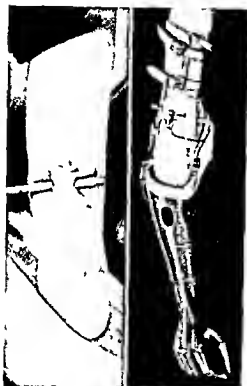


Fig 5 Congenital amputation of left arm just below the elbow In this case the biceps and triceps motors of the upper arm were utilized for activating the prosthesis *a* at right with prosthesis



Fig 6 No attempt was made to revise the stump Biceps motor canalized *a* at right triceps motor canalized note that above triceps canal is a small canal that was too superficial for active use



Fig 7 Another irregular stump which was not revised *a* at right showing both canals close to but avoiding the scar at the end of the stump



Fig 8 Disarticulation at the wrist with dorsal and volar motors *a* at center another view showing the irregular contour at end of stump *b* at right prosthesis *c* disarticulation not as satisfactory as amputation above wrist

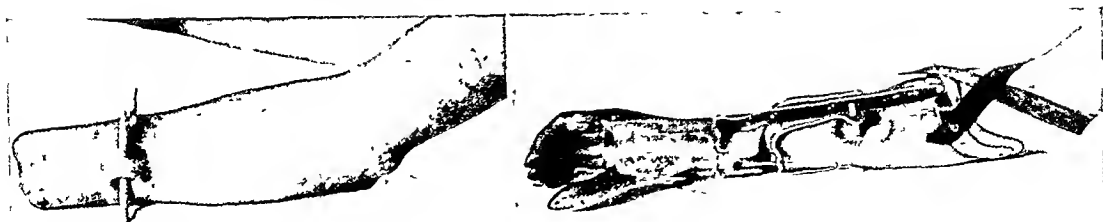


Fig 9 Amputation just above the wrist with double motors, a, at right, with prosthesis. This is more satisfactory than disarticulation at wrist since there is some play between the end of the stump and the hand mechanism.



Fig 10 Amputation at the junction of the lower and middle third of the forearm, a, at center, showing both motors with the elbow flexed, b, at right, with prosthesis.

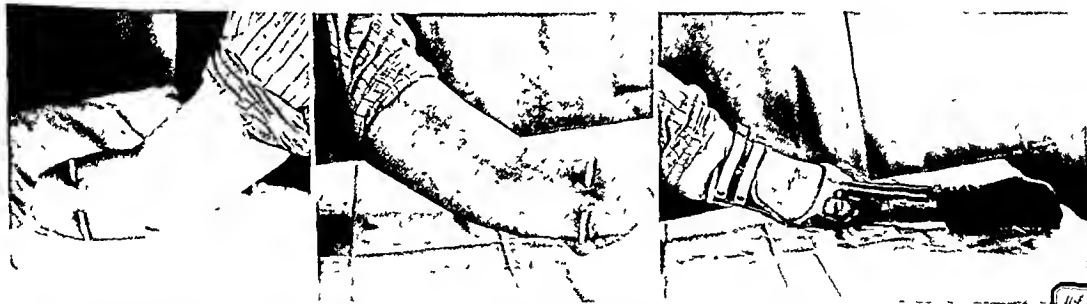


Fig 11 Amputation of upper third of forearm, dorsal view, a, at center, showing both motors, b, at right, with prosthesis. Because of the short stump it is necessary to secure additional leverage by extending the apparatus above the elbow.

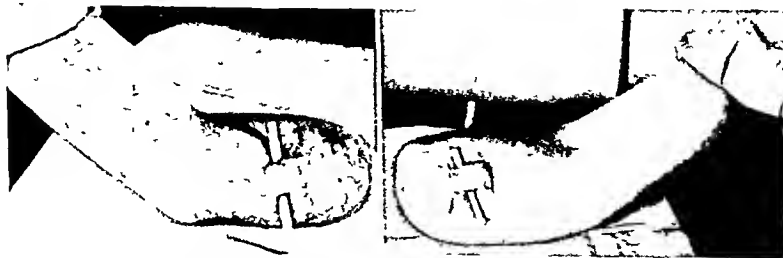


Fig 12 Upper third of forearm amputation, a, at right, showing both motors.



Fig 13

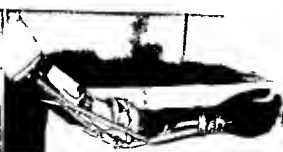


Fig 13a



Fig 13b



Fig 13c

Fig 13 Too short a forearm stump for utilizing the motors to activate any mechanism canals are used for fixation only a showing apparatus with circular band fixed to the forearm stump b hand mechanism controlled by total movement of the forearm stump instead of individual motors flexion of the elbow produced by strap attached to opposite shoulder c same in extended position



Fig 14 Congenital amputation with biceps motor a at right with triceps motor

work. The expectations of persons with amputations are frequently too great. They hope to be capable of doing absolutely independent work through the artificial appliance. The use of the prosthesis, however clever it may be, is a limited one, since the safety factors retained by the body in its capacity for compensation may be more valuable than the best mechanical construction. For example, one armed persons learn very rapidly to dress, undress, wash, shave and comb their hair, as well as to write with the remaining arm. The left hand gradually becomes the right hand and assumes all the tasks previously fulfilled by the right.

Because of the unsatisfactory experience with the ordinary mechanical arm, attention has been directed toward the development of a substitute



Fig 15 Traumatic disarticulation of the elbow joint showing biceps motor, a, at center, showing both motors, b, at right, with prosthesis

arm in which the control can be achieved by natural muscular action. This development is marked by the names of Vanghetti, Sauerbruch, Ceci, Putti, Pellegrini, and Bosch-Arana. Jottkowitz, in a survey of 729 cineplastic amputations, found 37 per cent of this group wearing their arms from 1 to 13 years after operation (5).

In the cineplastic amputation the remaining muscles in the amputated stump are utilized to activate the prosthesis. By means of pegs passed through canals in the muscles and attached to levers operating the artificial-hand mechanism, the physiological action of the stump muscles is restored. The biceps and triceps muscles in the upper arm and the flexors and extensors of the lower arm control the grasp and release of the fingers of the artificial hand. Thus, the stump retains its real task of guiding the hand without other problems added to it, such as leverage, in the case of a mechanical arm. Though the fingers of the artificial hand have no feeling, natural control is, nevertheless, exerted by the muscles in the act of grasping, thereby permitting a close approximation to natural hand function.

This report represents a preliminary analysis of the results of cineplasty in a group of 78 cases. While this series is too small for statistical treatment, it furnishes some basis for a discussion of advantages and disadvantages of this procedure.

**Age group.** The youngest case in the series was a 6 year old boy with a double arm amputation (Fig 1). The oldest person in the series was an individual 61 years of age (Fig 2). There would seem to be some advantage in performing this operation at an early age, while the wide variation in age range would seem to indicate that age in itself does not constitute any contraindication to the procedure.

**Type of amputation and stump.** The series included all types of amputations such as those due to public, street, and industrial accidents (Figs 3, 4, 5), disease and congenital deformity. In none

of the cases was any attempt made to revise the stump by secondary amputation. The stump was utilized even in the presence of scars and other deformities (Figs 6, 7). Short congenital stumps of the forearm were unsatisfactory for muscle canalization. A single fixation canal permitted attachment of the entire stump as a unit to the activating lever of the hand. Flexion and extension of the stump at the elbow produced opening and closing of the hand (Fig 13).

**Site of amputation.** This has varied from a disarticulation of the wrist to a very short or high upper arm amputation (Figs 8 to 22c). At this juncture it would seem pertinent to make a plea for consideration of a site for an amputation of the forearm. There is nothing to be gained by disarticulating or amputating at the wrist. Too long a stump is neither applicable for cineplasty nor for ordinary mechanical arms since the receiving extremity becomes much longer than the remaining extremity. Furthermore, the stumps are usually cyanotic and cold and have a tendency to break down because of poor circulation. From



Fig 16 Traumatic amputation through the condyles of the humerus showing biceps motor, a, at right, same showing triceps motor



Fig 13

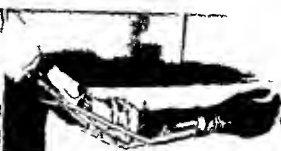


Fig 13a



Fig 13b



Fig 13c

Fig 13 Too short a forearm stump for utilizing the motors to activate any mechanism. Canals are used for fixation only. a showing apparatus with circular band fixed to the forearm stump. b hand mechanism controlled by total movement of the forearm stump instead of individual motors. flexion of the elbow produced by strap attached to opposite shoulder. c same in extended position.



Fig 14 Congenital amputation with biceps motor at right with triceps motor

work. The expectations of persons with amputations are frequently too great. They hope to be capable of doing absolutely independent work through the artificial appliance. The use of the prosthesis however clever it may be is a limited one since the safety factors retained by the body in its capacity for compensation may be more valuable than the best mechanical construction. For example one armed persons learn very rapidly to dress undress wash shave and comb their hair as well as to write with the remaining arm. The left hand gradually becomes the right hand and assumes all the tasks previously fulfilled by the right.

Because of the unsatisfactory experience with the ordinary mechanical arm attention has been directed toward the development of a substitute

utilizing his cineplastic arm effectively (Fig 24). In a third case the dorsal motor in a forearm amputation became infected, sloughed out, and the patient is now using a single motor cineplastic arm (Fig 25). In still another case, that of a colleague referred to me for a prosthesis, the dorsal motor was made too deep, became ulcerated and was finally allowed to close. A spring is now utilized in place of the dorsal motor.

*Fittings of prosthesis* In this entire series, the fitting of the prosthesis has been very satisfactory with the exception of 1 case. Only minor adjustments were necessary in a few cases to permit the amputee to utilize the apparatus immediately. With respect to repairs, the hand is exceedingly light, is made of wood and from time to time



Fig 21 High amputation with double motor, a, at right, posterolateral view



Fig 22 High upper arm amputation with extensive scarring leaving very little muscle, part of the deltoid and short head of the biceps were canalized and both utilized as one single motor, a, the triceps was utilized as a reciprocal motor, b, with prosthesis, c, the use of the prosthesis in playing the violin





Fig. 17 Amputation at the junction of lower and middle third showing both motors a at right with prosthesis

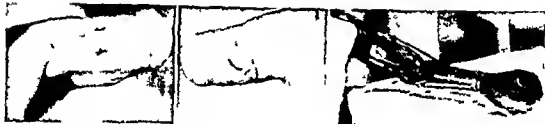


Fig. 18 Amputation about middle of upper arm showing the canal without the peg a at center same posterior view b at right with prosthesis



Fig. 19 High amputation of upper arm showing the method of utilization of the remaining biceps motor a at right photograph of the same arm showing triceps motor



Fig. 20 High amputation of upper arm with both motors. Showing the feasibility of still utilizing the remaining musculature for reciprocal motors a at right posterior view

the standpoint of cineplasty it is important to utilize the bellies of the muscle rather than the tendons and so an amputation at the junction of the middle and distal thirds of the forearm is most suited for this procedure.

**Time interval.** In 2 cases cineplasty was performed at the same time as the original amputation. The longest time interval between the initial amputation and the time of cineplasty was 30 years. This would indicate that these muscles can be retrained even after prolonged periods.

**Re-adaptation.** In this series of 78 cases 44 are now employed in remunerative work at such jobs as clerks, lithographer, painter, truck driver in

spector of transmission lines, watchman, track foreman, bookkeeper, leather embosser, machinist, elevator operator, fur sorter, laborer, accountant, inspector, helper in storeroom, needle board repair man (Fig. 21), commercial letterer and stereotype operator.

#### COMPLICATIONS

**Infection.** In this entire series there were 3 cases of infection. In 1 case of congenital amputation both canals became infected, sloughed out, and were lost. In another case of infection the canal sloughed out but this case was reoperated on, another motor was made and the patient is



Fig 24 Volar aspect showing canal intact, a, at center, dorsal aspect showing two canals. The proximal canal has been lost by infection, sufficient room remained for making a distal canal, b, at right, the hand in use with prosthesis

The results of this cineplastic amputation in a series of 78 cases are distinctly encouraging. Of this group, 44 may be classified as highly successful. These individuals are consistently using the prosthesis at work and in the routine pursuits of life over a period of from 2 to 6 years.

Of the 34 remaining, 19 enjoy partial utility of their prosthesis. Unusual work requirements may render it impractical even to wear the arm at work, as in the case of 1 worker in a chemical

plant who must immerse both arms in a solution as part of work operation.

Of the 15 that can be classified as failures, 5 have been due to surgical complications. Infection of the skin tube, necrosis due to previous x-ray dermatitis, improper placement of canals, too short a stump for utilization of leverage of muscle motors, and improper fit of prosthesis account for these failures. The remainder found it difficult to adjust themselves because of personality factors.

#### CONCLUSION

The use of the cineplastic amputation in selected cases is of distinct advantage in the rehabilitation of the armless. Through the natural control obtained by this procedure the individual is able to utilize the assistance of the amputated arm in the performance of his daily tasks. By increasing his efficiency, he restores his confidence in himself and his ability to compete with others. He is thus equipped to partake of a fuller life without asking for any special considerations.

#### REFERENCES

- 1 BOSCH-ARANA, G. *Semana méd*, 1921, 566 301
- 2 CECI, A. *Amputazioni plastico-ortopediche secondo Vangbetti*. Cong ital di chir, October, 1905
- 3 FARIES, J. P. *Limbs for the Limbless*. New York: Institute for the Crippled and Disabled, 1934, p 13
- 4 JOTTROWITZ, P. *Ergebnisse der orthopaedischen Versorgung der kriegsbeschädigten Armamputierten*. Deutschlands Arbeit und Gesundheit, 1931, 19 29
- 5 *Ibid* p 35
- 6 LITTLE, M. E. *Artificial Limbs and Amputation Stumps*. Philadelphia: P. Blakiston's Son & Co., 1922, p 87
- 7 PELLEGRINI, A. *Chir d org di movimento*, 1917, 1 5
- 8 PUTTI, V. *Chir d org di movimento*, 1917, 1 292
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Fig 25 Single volar motor, a, prosthesis for single volar motor, volar motor closes hand and spring is utilized for opening hand

fingers are knocked off but can be grafted back again. Where the work requirements are such as to indicate need for an arm of heavy construction, this can be supplied by substituting a metal hand or wooden hand reinforced with metal.

**Unsatisfactory results.** The difficulties that do arise can be ascribed to 3 factors: the patient, the operative procedure itself, and the prosthesis.

**The patient.** Unless the patient is co-operative, the best surgical result and the best type of prosthesis will be useless. The expectations of the amputee are frequently too great. He expects to duplicate the physiological act of prehension with all its infinite variations. Even with ordinary mechanical arms, the individual is deceived by the unusual skill of the salesman. The latter, by dint of years of practice and adaptation, has achieved an almost artistic perfection, one which the new amputee cannot accomplish in a short time. Discouraged by his lack of success, the limb is soon discarded. The cineplastic arm has the advantage of depending on a natural physiological process. The re-education occurs in a simple manner in a short space of time.

#### OPERATIVE PROCEDURE

The site of the motor is selected and a 3 sided flap of the skin and subcutaneous tissue turned up each side being  $1\frac{1}{2}$  inches long. The skin tube or loop is prepared by reversing the flap and securing the end of the tube with a silk suture. The rest of the tube is approximated with subcuticular sutures of fine gut closely placed in order to insure perfect apposition. The tube is retracted and the muscle prepared for canalization. Two parallel incisions are made in the muscle belly and an instrument passed through the muscle to form a canal.

The skin tube is then passed through the canal holding the traction suture in the most superficial position in order to avoid distortion of the tube. The edge of the tube is sutured to the adjacent skin. This leaves a skin defect which must be closed. In young children in the upper arm in adults and in those cases in which there is a redundancy of skin in the amputation stump of the forearm it is possible to close the defect by direct approximation of the skin edge. More frequently this cannot be accomplished without danger of skin necrosis. In this event the wound defect is covered with a Thiersch graft. Zeroform gauze wicks are then inserted in the canals. The first dressing is done in about 10 days, the pegs are inserted in about 3 weeks and the stump is ready for prosthesis in about 6 weeks.

There are only a few points that need emphasis to avoid failure. It is most important to select



Fig. 23. Forearm and upper arm amputation in use in factory where needle board is being repaired.

the proper muscle or muscle group for canalization. It is impossible to tell beforehand just which muscles remain after the amputation. We depend therefore on the clinical test of visualizing the contraction of the muscles to be selected in response to the psychophysiological act of opening and closing the hand at the site of amputation. The patient must therefore, be awake and the muscles outlined with a skin dye just before the operation is undertaken.

The second important step, neglect of which has been responsible for many failures in the past is to canalize the muscle and not the tendon. The latter has no contractility. The activation of the artificial hand mechanism depends on the movement of the peg which passes through the tube. This movement varies from  $\frac{3}{4}$  to  $\frac{1}{2}$  inch and is due to the alternate shortening and lengthening when the muscle contracts or relaxes.

**The prosthesis.** It is not difficult to manufacture the cineplastic arm. It is important that the weight of the apparatus be kept to a minimum. Furthermore, the mechanism should be as simple as possible. The more complicated the prosthesis the less useful the arm. Theoretical advantages should be sacrificed for practical utility. For example, there is no need for incorporating a rotation mechanism at the wrist in forearm cases since pronation and supination of the stump are still retained. However, in upper arm amputation, this rotation mechanism is of distinct value.

The arm can be designed for heavy as well as light duty, depending on the indications in the specific case. In the forearm amputation no straps or apparatus are required above the elbow. In the upper arm amputation a strap to the opposite shoulder is necessary to secure flexion of the elbow.



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1. BOSCH-ARANA, G. *Semana méd*, 1921, 566, 301.
2. CECI, A. *Amputazioni plastico-ortopediche secondo Vanghetti*. *Cong ital di chir*, October, 1905.
3. FARIES, J. P. *Limbs for the Limbless*. New York: Institute for the Crippled and Disabled, 1934, p. 13.
4. JOTTKOWITZ, P. *Ergebnisse der orthopaedischen Versorgung der kriegsbeschädigten Armamputierten Deutschlands*. *Arbeit und Gesundheit*, 1931, 19, 29.
5. *Ibid*, p. 35.
6. LITTLE, M. E. *Artificial Limbs and Amputation Stumps*. Philadelphia: P. Blakiston's Son & Co., 1922, p. 87.
7. PELLEGRINI, A. *Chir d'org di movimento*, 1917, 1, 5.
8. PUTTI, V. *Chir d'org di movimento*, 1917, 1, 292.
9. SAUERBRUCH, F. *Die willkuerlich bewegbare kuenstliche Hand*. Berlin: Julius Springer, 1916.
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# FRACTURES OF THE BONES OF THE FACE

JAMES BARRETT BROWN, M.D. F.A.C.S., St. Louis, Missouri

**F**ACTORS of importance in extensive facial injuries may be listed as follows: (1) When a patient is examined following a severe blow about the face it is best to suspect a fracture and work from that point. If it is assumed that the possibility of fracture can be considered when the swelling has gone down, or, if soft tissue repairs are carried out with disregard for displaced bone fragments, the best chance for correct bone replacement has been missed. (2) Possibilities of good repair are present in almost all instances but must be met promptly and adequately. (3) Simple procedures of accurate replacement and holding of bone and soft parts, drainage and bandaging should suffice and, with relatively simple equipment, sound care usually can be afforded these patients. (4) The reverse is true if the full picture is not clear to those in charge and restorative measures are lax. (5) Although the lesions may be multiple, complicated splints and traction are seldom required and may actually be detrimental in some instances. It is important, however, to have available some one cognizant of the dental requirements and means of fixation because one of the most important functions to be preserved is that of mastication and this requires that the teeth come together in normal occlusion. (6) The problems presented by fractures about the upper part of the face require careful evaluation and diagnosis. If tissue has been completely lost, this point is of extreme importance in the final outcome, and the extent of loss should be recorded either in the original examination or at the time of operation. (7) Skull fracture and brain injury are so frequent that neurological examination, including x-ray films, often must be made and local repair delayed if there is any lesion that requires treatment or complete rest. Patients who receive 'snap' blows about the head may have damage to the cervical spine and on the slightest indication this region also should be checked with the x-ray. (8) Ocular damage is very frequent and is often the main indication for treatment. (9) Although good position and function may be obtained, final bony union may never occur in many

instances. This may be due to the very thin edges of bone, that simply do not unite and also to prolonged infection. In the lower jaw there may be solid union but with persistence of the fracture line on x-ray.

## ASSOCIATION OF BONE AND SOFT TISSUE DAMAGE IN COMPOUND INJURIES OF THE FACE

The lacerations, avulsions and tears of the soft parts, and the fractures and displacements of the bones may be so numerous that it may be difficult to list all the diagnoses, and the term "compound injury of the face" could be used as a rough classification. Although widespread soft tissue damage often occurs without fracture, and very extensive comminuted fractures result from blunt force which may not even break the skin the two occur together so frequently that it is not possible to separate completely the repair work of bone and soft tissue.

## X-RAY EXAMINATION

It is not necessary to rush these patients to the x-ray room, because most operative procedures can be done without the pictures and the necessary manipulation in the x-ray room might be contra-indicated if there were skull or cervical spine damage. However, when safe for the patient, complete views of all involved regions should be taken.

In roentgenograms of the upper jaw the bony ridges of bone show quite well in antral and in verticobasilar positions but there may be many comminutions of the maxilla, ethmoid, nasal, and other thin bones that are entirely missed on the x-ray plate and therefore this condition has to be searched for at the time of operation. Complete skull and cervical spine series should be taken as indicated before. For the lower jaw complete views of both sides including both condyles, should always be taken because multiple fractures may be missed even at operation. The laminograph developed by Dr. Sherwood Moore and designated as body section radiography gives the most accurate information of the joint area.

## PRIMARY REPAIR TO BE DONE EARLY IF POSSIBLE

These wounds and fractures should be cared for in the first 20 hours if possible before excessive

From the Department of Surgery, Washington University School of Medicine.

Presented at the Symposium on Fractures before the Clinical Congress of the American College of Surgeons, New York, October 17, 1953.



a

b

c

Fig 1 a, Extremely widespread soft tissue injury plus complete separation through the symphysis b and c, Com-

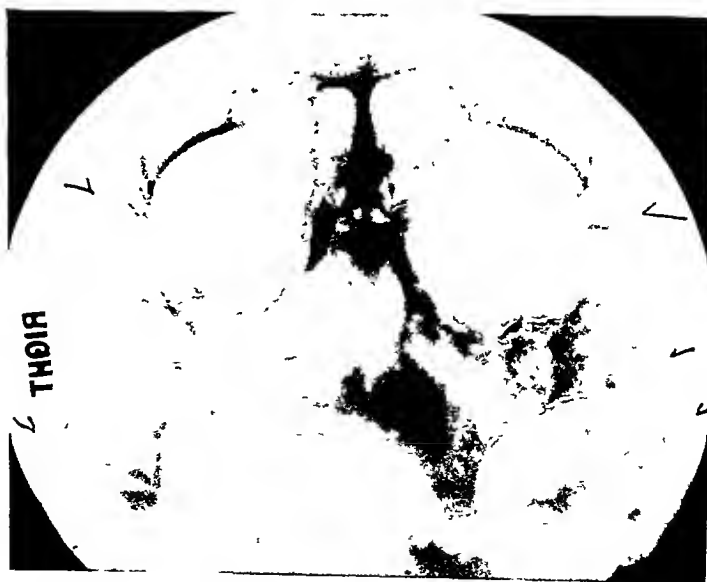
plete restoration in 1 operation which was done a few hours after the accident

swelling, organization of clots, and infection have occurred This necessitates work at odd hours of the day and night, and it is recognized that the

statement has been made frequently that the repair of facial injuries should be delayed several days If the patient is seen after this time and



a



b

Fig 2 a, Diagram of frequent separations of the upper jaw, to which should be added a loosening all the way around on both sides just above the alveolus b, Multiple comminutions of the facial bones, some of the areas having

been scratched in for clearness Separation of the zygomatic-frontal suture lines on both sides, crumpling of the zygomatic arches, and comminution about the orbital borders and antrum





Fig 3 Representative patient with complete facial separation. A patient who had suffered multiple comminuted fractures of practically all the bones of the face shown 3 weeks after operation which was done under basal and deep block anesthesia 1 week after the accident. The nose was completely loose and shattered and as a result of swelling was just on a level with the cheeks. An air way was established through both nostrils with a long speculum and maintained with rubber tubes. The palatal processes had cut through the palate in 3 places and these were forced back into place at the same time. The dorsum of the nose was elevated and held with a double ling of silver wire from side to side put through the fracture lines along the frontal processes with large cutting needles and held on the side of the nose over lead plates as shown. The inner canthi were widely separated by an actual chiseling open of the face as the nose was driven backward. The canthi were replaced at the same time the nose was elevated and the fixation of the nose has helped to assure correct position and direction of the inner canthi. The orbital borders, zygoma and antrum are considered together because as the zygoma is loosened the border goes down and the antrum crumples under it. If the zygoma is driven backward the

zygomatic process of the temporal bone is crumpled either in or out. Restoration is done by making a small incision in the upper buccal foramen entering the antrum through the fracture line and then replacing the orbital border the frontal process and the bulk of the zygoma and if necessary packing the part in place by filling the antrum carefully with an iodoform gauze pack. The fragmented zygomatic process may be carried inward by external pressure or lifted out with a small hook under it placed either from the outside through the mouth or down from the temporal region as suggested by Gillies. The upper alveolus was broken in all the way on the left and was carried back into position and held with direct wires on the teeth across the fracture line and finally with fixation to the lower jaw. The lower jaw was broken through the symphysis and was held with the type of fixation shown in Figure 5b the upper jaws were used to support the lower and vice versa although both were broken. b and c Shows complete restoration of contour with normal expression normal position of the inner canthi no diplopia normal vision and normal occlusion. The most prominent feature of the profile the dorsum of the nose is restored. 1 operation

there would be the necessity of manipulation through contaminated clots and edematous tissue the replacement of bone might be delayed until there is subsidence of the swelling although the soft parts might still be approximated. The replacement of bone fragments should not be delayed longer than 7 to 10 days under nearly all circumstances because the fixation of small comminuted chips after this time may make impossible their correct alignment.

Shock and neurological damage may necessitate delay in early repair and if a patient is intubated the jaws should not be wired together.

#### GENERAL CONSIDERATIONS OF THE OPERATIVE PROCEDURES

It may be best to wait until the patient is in the operating room before any manipulation is done, so that there will be the least discomfort. Then a complete analysis should be made of what is nec-



Fig 4. a, b, Simple type of splint for elevating dental arch and face. Made by Dr J A Brown for use in patient shown in d and e. The tray is filled with dental compound before it is used, and is held with a simple elastic sling from the top of the head. d, Patient with blindness in left eye, complete transverse and multiple facial fractures with

almost total loss of the left upper jaw. e, Restoration of occlusion, nasal position, and of the cheek prominence with a free costal cartilage transplant. The right inner canthus is still somewhat displaced, as evidenced by the sharp curve of the tarsal border.

essary in order to carry the repair, in definite steps, to completion. For example, the patient in Figure 1 was so uncomfortable because of a symphysis fracture that this was fastened together first, by drilling and direct fixation of the fragments. He was immediately more comfortable, and then the repair of the floor of the mouth, chin and lip was completed. Next, the upper part of the face, nose, ear, eyelid, and scalp were repaired, and by using clean instruments, gloves, and drapes throughout, there was no further mouth contamination.

Anesthesia is usually obtained with novocain, locally, or by deep block of the second and third division of the fifth nerve. A basal drug can also be given, but general anesthesia should be avoided, except that it is necessary when dealing with children.

#### DÉBRIDEMENT AND PRESERVATION OF TISSUE

Cleaning of these facial wounds is extremely important and should be done with soap and water followed by ether and saline irrigations so that local antiseptics are seldom necessary, anesthesia may have to be given before the cleaning is completed because of pain. Oil ground into the face should be scrubbed and dissolved out completely. Bits of glass from rear vision mirrors or from completely broken shatterproof glass are especially

apt to be overlooked, and for this reason it is well, if possible, to find out whether or not any glass was broken at the time of the accident so that search may be made accordingly.

Débridement should be done very sparingly both of soft parts and bone. If the usual idea of wide excision of torn edges were applied, many parts of features would be needlessly sacrificed. In dealing with loose bone chips extreme conservatism should be adhered to, and it is probably better to leave in some bone fragments that might die rather than adopt the policy of removing all loose fragments and thereby possibly discard many good supporting fragments that might live.

#### SUTURE OF SOFT TISSUE

As stated, the repair of jaw fractures cannot be totally separated from the repair of the soft parts and, therefore, a brief summary is included here.

In complicated tears such as shown in Figure 1, a correct replacement may be difficult, but a start is made at some known point such as the nostril border, or the edge of the eyebrow. If none can be figured out, closure may be started in the center of a wound and the remaining segments bisected with sutures until there is complete closure. If flaps are torn loose in a trap-door or triangular manner, their correct re-approximation is extremely important if involving a feature. In this



Fig. 3 Representative patient with complete facial separation. a Patient who had suffered multiple comminuted fracture of practically all the bones of the face shown 3 weeks after operation which was done under basal and deep block anesthesia 1 week after the accident. The nose was completely loose and shattered and as a result of swelling was just on a level with the cheeks. An air way was established through both nostrils with a long speculum and maintained with rubber tubes the palatal processes had cut through the palate in 2 places and these were forced back into place at the same time. The dorsum of the nose was elevated and held with a double sling of silver wire from side to side put through the fracture lines along the frontal processes with large cutting needles and held on the side of the nose over lead plates as shown. The inner canthi were widely separated by an actual chiseling open of the face as the nose was driven backward. The canthi were replaced at the same time the nose was elevated and the fixation of the nose has helped to assure correct position and direction of the inner canthi. The orbital borders, zygoma and antrum are considered together because as the zygoma is loosened the border goes down and the antrum crumples under it. If the zygoma is driven backward the

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there would be the necessity of manipulation through contaminated clots and edematous tissue, the replacement of bone might be delayed until there is subsidence of the swelling although the soft parts might still be approximated. The replacement of bone fragments should not be delayed longer than 7 to 10 days under nearly all circumstances because the fixation of small comminuted chips after this time may make impossible their correct alignment.

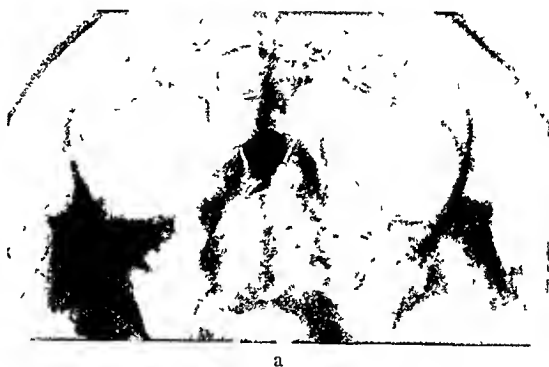
Shock and neurological damage may necessitate delay in early repair and if a patient is intubated the jaws should not be wired together.

#### GENERAL CONSIDERATIONS OF THE OPERATIVE PROCEDURES

It may be best to wait until the patient is in the operating room before any manipulation is done so that there will be the least discomfort. Then a complete analysis should be made of what is nec-



Fig 6 a, Comminution of the facial and frontal bones with involvement of the frontal sinuses, displacement of the inner canthi, and flattening of the nose b, Patient seen a few hours after the accident and restoration done immediately, that is, replacement of the comminuted fragments, rubber tube left in frontal sinus to drain into the nose, fragments of nose held up and inner canthi replaced by through-and-through silver wire sutures, placed through the fracture lines of the frontal processes and held over lateral lead plates on the outside of the nose c, d, Restoration of the nasal bridge and normal direction and situation of the inner canthi (one operation)



much that binocular vision is impaired (Figs 3, 4, 7, 8, 9, 11). Blindness may result from section of the nerve by a loose, thin piece of bone and from intra-ocular or direct ocular damage. The extra-ocular muscles and nerves may also be torn (Fig 4). The lacrymal apparatus may be impinged on if the frontal process of the maxilla is driven in.

*Inner canthus displacement* occurs if the nose with the frontal processes of the maxilla is crushed backward, there being an actual chiseling open of the front of the face. This deformity is as important as any other in which to accomplish an early repair, because, if left until fixation occurs, the canthi probably never will be sunken in normally again (Figs 3, 4, 6, 11).

*Nasal flatness* goes along with the canthus displacement and the two are corrected together by withdrawing the depressed tissues and bones, molding them into their normal positions, and

frequently holding them there with through and through silver wire sutures inserted under the separated frontal processes and held on the outside of the nose over lead plates (Figs 3, 6, 10).

The general rule for repair is simply to replace these fragments and maintain them in position with the least manipulation possible. This replacement amounts to an open reduction, and access to the orbital border can be gained by a short incision in the buccal fornix, then into the antrum through the fracture line that is almost always present. The depressed border can then be elevated into position with a Kelly clamp. This bone may be locked in place, but, if there is much comminution, the whole number of fragments, including the anterior and lateral walls of the antrum, may be "mulched" in position and held with an iodoform pack in the antrum, with the end left just through the opening in the fornix.



Fig 5 a Permanent loss of occlusion in upper jaw fracture which might have been prevented by using the lower jaw for a plant by simply wiring the 2 jaws in occlusion. b Method of Risdon in applying an anterior arch by putting long wires on the posterior teeth, bringing them around in front, fastening them together and then anchoring individual teeth to this arch with finer wires. Besides this sup-

port which is used mainly for symphysis fractures fixation to the upper jaw with the teeth in normal occlusion is done and support applied from the chin to the vertex if necessary. c Functional result obtained in a patient with a fracture at the symphysis and through both condyles as well as a separation in the left upper jaw by using the fixation shown in b.

patient (Fig 1), the entire eyelid was closed in a position too far advanced on the forehead and the lid had to be opened completely and resutured before the patient left the operating room.

Close attention should be paid to the wound edges to see that they are in apposition and of course very ragged edges should be cleanly excised. The first sutures may have to be deep but should never be placed far from the wound edge because wide suture marks can never be completely obliterated. Many times widely placed sutures may be put in however but left open until the entire wound is closed then they are tied over a gauze pad to bind the wound closely together and to avoid the surface cutting of the suture.

It is best to effect complete closure of the wound with deep fine No. 000 white silk sutures so that when the final skin sutures are inserted they are merely to support the edges and adjust them. If possible stay sutures may be put in from the inside of the cheek or nose.

Small drains may be placed advantageously and firm pressure dressings of mechanics waste or marine sponges can be applied finally to control hemorrhage and swelling and thereby infection.

#### DISPLACEMENT OF THE BONES OF THE UPPER JAW

Transverse facial fractures occur usually from heavy blows dispersed over the face. There may be a level of separation at the frontal zygomatic suture line and at the glabella on both sides there

may be one through the wall of the antrum that may extend all the way around and involve the pterygoid region and frequently there is a complete separation entirely around just above the dental arch. The whole face may sag down and become noticeably elongated and the dental arch may be completely loose to the patient's own sensation and on moving it with the examining fingers (Figs 2, 3, 4, 5, 6).

Nasal, septal, and palate fractures frequently occur along with the above separation and these small thin bones may be comminuted into multiple pieces. The nasal structure including the cartilages may be completely crumbled and there may be one or more complete lacerations through the palate caused by the disrupted bone cutting through the nasal passages may be completely occluded also (Figs 3, 6, 10).

The zygomatic bone and orbit. The zygomatic bone (malar or cheek bone) frequently receives the blow but is itself seldom broken. Instead it is torn loose from its moorings at the frontal zygomatic process of the temporal bone and the maxilla. The main displacement will be according to the direction of the force if from the front the zygomatic process will be crumpled back and broken by the zygoma itself if from the side the ascending ramus of the zygoma may be tipped in and impinge on the orbital space. In nearly all loosening of this bone the antral wall crumples and should it sag down too much the orbit becomes elongated and the globe may descend so



Fig 8 a, Marked displacement of entire zygoma after 2 weeks with no hope of holding it in position from the inside of the antrum, because it is broken so far away laterally from any support b, Zygoma replaced and held by direct

wiring from ascending ramus to frontal bone, access to bone gained by opening a scar of accident This elevation is usually not successful if fragment becomes firmly fixed out of position, then globe has to be elevated within orbit (see Fig 9)

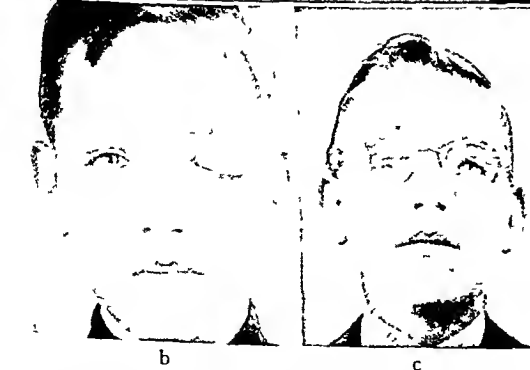


Fig 9 a, Loss of lateral wall and floor of orbit so that no elevation is possible b, Patient whose x-ray film is shown in a The main object of restoration is for eye function, as there is marked depression of the bony orbit, complete ptosis of the lid, and paralysis of the frontalis c, Globe

both condyles This illustrates the use of the lower jaw to splint the upper

*Fractures through the frontal and ethmoid sinuses; inner canthus displacement.* Sinus involvement is shown in Figure 6 with the fracture through the wall of the frontal, and with wide separation of the inner canthi and complete flattening of the nose, repaired so that practically normal position of the canthi and of the nasal dorsum results with a simple fixation as shown in Figure 3c

With involvement of the frontals and ethmoids there is some possibility of direct dural contamination, and the added precaution must be taken to maintain drainage into the nose without irrigation or manipulation that might carry infection up to the dura If the sinuses are already infected, the chance of spread is greater

*Elevation of orbital border through buccal fornx, incision and antral fracture line* In Figure 7 the inner part of the orbital ridge is down in a and is back in place in b, supported with an iodoform pack in the antrum In c and d the normal profile and, from the front, the normal position of the globes and the inner canthi are shown

elevated with 1 block of free costal cartilage and held medially with another With this replacement of the globe there was subjective improvement in the ease of ocular movements Binocular vision does not always return after this procedure because of the delicate balance necessary for this function Elevation of the lid was obtained by a fascial loop to the forehead and a second long one from the temporal fascia through the tarsus to the opposite frontalis The upper orbital border was restored with a costal cartilage transplant put in a periosteal sling to give good fixation of the graft All 3 pieces of cartilage were fresh homografts from the mother



a



b



c

d

Fig 7 a Depressed orbital border b Orbital border has been raised by going through the buccal fornx into the antrum through the fracture line in the anterior wall, and then elevating the fragment with a Kelly lever. The border and orbital floor are held up in place with an iodiform pack if it is thought that they will not stay up without it c d Result of patient whose x ray films are shown in a and b obtained by a single but early operation with good position resulting in both the globe and the inner canthi. There had also been extensive tearing of the ear and nose

If there is derangement of occlusion, the lower jaw can be used to splint the upper by fixation of the teeth followed by the application of a bandage from the chin to the top of the head. Frequently the closing power of the muscles attached to the lower jaw will suffice for this and the overhead pull can be omitted (Figs 4 5)

#### ILLUSTRATIONS OF GENERAL TYPES OF LESIONS

The most frequent lesions are described by the following representative patients and the legends of illustrations may be followed as part of the text

*Restoration of contour after complete facial fractures without special splints* Diagrams and roentgenograms of typical complete facial separations are shown in Figure 2 and a patient completely restored after the most extensive facial fractures of this type is shown in Figure 3 with the operative procedures outlined in the legend

*Elevation of sagged upper jaws with dental splint* In Figure 4 a simple type of apparatus for elevat-

ing upper jaws is shown, made by Dr J A Brown for use in the patient shown in Figure 4 d and e. Thus does not insure normal occlusion and when it is removed, if there is any tipping of the upper alveolus, the teeth should be forced into their normal occlusion and held there by interdental wiring to the lower jaw and, if necessary, support should be applied from the chin to the head

*Blindness in compound facial injury* The patient in Figure 4, d and e illustrates the loss of vision frequently seen and shows fairly normal replacement of the soft parts re-establishment of occlusion and the bulging out of the depressed left cheek with costal cartilage

*Loss of occlusion in upper jaw fracture* is shown in Figure 5a where interdental fixation with the teeth in occlusion had been omitted

*Anterior dental arch plus jaw to jaw fixation* is shown in Figure 5b the type used in the patient in Figure 3 and also in the patient in Figure 5c who had a symphysis separation and fractures of

*Direct fixation of a completely loose zygoma* is shown in Figure 8 by drilling the frontal bone and the ascending ramus of the zygoma and anchoring them together. It was done in this instance because the very loose bone could not be supported from inside the antrum.

*Consideration of late deformities* If the late deformities are studied, the requirements of early care may be made more clear, and, since many secondary corrections have to be made, some responsible person or the patient himself should be told of this possibility in all severe injuries.

*Elongation of the orbit because of depression and loss of zygoma* is shown in Figure 9. Restoration of eye level has been obtained by elevation of the globe with costal cartilage transplants along the floor and in the lateral region.

*Late restoration of nasal bridge and profile*, using the tissues that have been crumpled in, is shown in Figure 10, a, b and c. The depressed bone and cartilage dorsum was literally dug out of its en-

folded position and then held forward on silver wire shngs from side to side.

*Late restoration of profile with costal cartilage transplant* is shown in Figure 10, d and e, where it has been recognized that tissue has been lost at the time of the accident or from infection. Elevation is effected with transplanted costal cartilage cut in one large piece to replace the entire loss of the septum and give support to the tip through the columella.

*Filling in of skull defects, secondary soft tissue correction, and correction of traumatic ptosis*, is shown in Figure 11. The lid has been brought down so that closure can occur, by "backing" some of the forehead tissue down into the lid in the form of a V-Y operation and going only through the old scars. The depression of the forehead has been filled with a free fascia lata transplant. Cartilage may also be used for this. The residual ptosis has been corrected with a free fascial loop from the tarsus to the frontalis muscle.

## DOUBLE PIN SKELETAL FIXATION IN FRACTURES OF THE LEG

R. ARNOLD GRISWOLD, M.D., F.A.C.S., and GEORGE W. HOLMES, M.D.,  
Louisville, Kentucky

CHANGES in automobile design a few years ago had a profound effect on the treatment of fractures of the leg. The most important factor was the increase of power, speed, and force of impact, which caused great damage to both soft and osseous tissues and resulted in a larger percentage of compound injuries. Four-wheeled brakes and smaller wheels changed the usual point of impact on the pedestrian from the knees to the mid-third of the leg. The result has been severe crushing injuries to the leg, with extensive damage to the bones and soft parts. The injuries to muscles, blood vessels, and nerves contribute greatly to the difficulties of treatment and to the time required for healing and restoration of function. These fractures are often bilateral and are frequently accompanied by injuries to other parts of the body.

From the Louisville City Hospital and University of Louisville School of Medicine.

Presented in the Fracture Symposium before the Clinical Congress of the American College of Surgeons, New York, October 17-21, 1935.

The flow of large numbers of these seriously injured patients into our hospitals has had a greater effect on the treatment of fractures in this country than anything since the World War. One of the outstanding developments in this field has been the introduction of numerous methods for skeletal control and fixation of fragments, by the insertion of steel pins in both proximal and distal fragments, and the incorporation of these pins in plaster encasement. This method was adopted at the Louisville City Hospital in 1933, and has been used since that time to the exclusion of all other operative measures. It is not indicated when adequate manual reduction and plaster fixation are possible. It is used only in those cases which we would have treated formerly by continuous traction or direct open reduction and internal fixation. In our city hospital service, which includes a disproportionate number of severe and complicated injuries, the double pin method is used in about half the cases. In private practice the proportion is smaller on account of





Fig 10 a Complete depression of the nasal dorsum from injury without loss of tissue b c Complete restoration of dorsum by chiseling free the depressed bone and

cartilage and holding it forward on a mattress wire sling d e Depression following injury plus loss of tissue so that free cartilage transplant is necessary for elevation as in c

*Zygomatic bone versus zygomatic process fractures* Some confusion has arisen in relation to these two fractures both of which are illustrated in Figure 7 a and b The zygomatic arch is part of the temporal bone and is broken only occasionally

by itself but is often crumpled in or out by fractures of the zygoma The various maneuvers recommended to lift out zygomatic process fractures do not usually apply to true displacements of the zygoma itself



Fig 11 a Depression of frontal area deformity of lid and inner canthus b Lifting of backing tissue down into lid from forehead in a procedure through old scars

c Result of fastening tarsal border to frontalis muscle for elevation of lid and eliminating the bony depression with free fascia

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the generally less severe damage. The apparatus which we use is a simplified version of the ones previously described (1, 2), and has recently been modified by Dr. Edward B. Mersch of the Louisville City Hospital staff. This apparatus provides adequate control and fixation of proximal and distal fragments, and gives adequate room for operation or fluoroscopic examination.

#### ROUTINE PROCEDURE

1. After careful clinical and x-ray examination and recovery from shock, local or spinal anesthesia is administered.

2. One-eighth inch steel pins are driven through the os calcis and through the tibia at the level of the tibial tubercle. If the fracture involves the upper end of the tibia, the proximal pin is inserted through the lower femur. Pins are inserted directly through the skin without incision and are driven through the bone with a hammer rather than drilled. The tight grip of the bone on the driven pin prevents motion which may lead to infection. It is important that the pins be driven only through the cancellous extremities of the bone, since driving pins through the hard cortical bone in the shaft may split the bone.

3. The limb is placed in the apparatus and the pins fixed in place. Traction is applied and reduction completed by mechanical manipulation under visual control with a right angle hand fluoroscope. This fluoroscope, which contains a 45 degree angle mirror, can be used in small spaces and at angles where a straight fluoroscope would be impractical. It also protects the operator from direct radiation.

4. After reduction, traction is reduced to allow firm end-to-end contact of fragments. Overtraction by such powerful mechanical devices may contribute to delayed union.

5. A non-padded plaster cast is applied from toes to groin as soon as the condition of the soft tissue warrants. This cast firmly incorporates both pins.

6. Ambulatory treatment is started after application of the cast. The cast and pins are removed at the end of about 8 weeks. A new cast may be applied at this time as high as the tibial tubercle or the upper thigh according to the site of fracture and the progress of union. This cast takes the place of a convalescent brace until unprotected weight bearing is safe.

7. Compound fractures are treated by thorough debridement after fixation in the apparatus. Those debrided within 8 hours of the time of injury are usually closed primarily. Closure in layers is avoided and the skin only is closed. In

interrupted sutures allow oozing of blood and serum from the wound. No drains are used. The wound is left exposed to air without dressings. Older wounds are packed open with vaseline gauze after debridement. A prophylactic dose of gas and tetanus antitoxin is administered in all compound injuries. The extremity is left in the apparatus for observation and treatment of the wound until its condition permits the application of plaster.

From July 1, 1933, to June 1, 1938, 576 patients with fractures of 1 or both legs were admitted to Louisville City Hospital. Three hundred and eleven of these were recorded as due to automobile accidents. 55 died within 48 hours of shock and associated injuries such as intracranial damage. Two of these deaths were attributed to fat embolus. Thirty six were transferred elsewhere after first aid treatment. The 485 remaining patients had 512 fractured legs. Three primary amputations were carried out for severe crushing injuries. Our reluctance to perform primary amputation may explain 3 amputations subsequently found necessary and may have been a factor in the 5 subsequent deaths from gas infection. Of the 509 extremities treated, double pins were considered necessary in 259. The 250 remaining cases with less severe injuries were treated by traction and manipulative reduction followed by the application of non-padded casts and walking irons. The treatment of these cases was carried out almost entirely by the resident staff of the Louisville City Hospital under only moderately close supervision. Four hundred and sixty patients were followed for a long enough period to judge the results of treatment.

#### RESULTS

Of 171 simple fractures not requiring pins, 153 healed within 2½ months and 16 healed within 6 months. Of 16 simple fractures into joints not requiring pins, 12 healed in 4 months and 4 within 6 months.

In a group of 21 compound fractures not requiring pins, 20 healed within 6 months. One case of delayed union was treated by subcutaneous drilling and had good union at the end of 12 months. Four of 5 compound fractures into joints not requiring pins were healed in 5½ months. One developed osteomyelitis and required 2 years for recovery.

We had 101 simple fractures requiring pins, 93 of which healed within 4 months. There was 1 amputation in this group due to arterial thrombosis. Too early application of a cast to a poorly nourished extremity probably caused this thrombosis. Five cases showed no union at the end of

6 months. All were treated by subcutaneous drilling, which resulted in union in all cases. In a group of 16 simple fractures into joints requiring pins, 12 healed in  $4\frac{1}{2}$  months, while 4 required 7 months for restoration.

There were 130 compound fractures requiring pins. One hundred and five of these healed within  $6\frac{1}{2}$  months, 8 healed following persistent ambulatory treatment, 6 cases of delayed union, which were submitted to drilling, healed within 18 months. One other did not respond to drilling but healed following a sliding bone graft. There were 7 deaths in this group, 5 due to gas infection and 2 to late shock. There were 3 secondary amputations, 2 for defective blood supply and 1 for gas infection.

Double pins were used in a total of 259 fractures, that is, 518 pins were inserted. Complications due to these pins, which were noted or severe enough to require treatment, were as follows: There were one mild and one severe osteomyelitis, 8 infections of soft tissue, 2 of which had persistent draining sinuses.

#### COMPOUND FRACTURES

Recapitulation of the 156 compound fractures treated shows that débridement and vaseline gauze pack were used in 25. Thirteen of these wounds healed well. There were 2 gas infections with death and 1 amputation for defective blood supply. Osteomyelitis of mild degree occurred in 7. There were 2 deaths due to late shock.

Primary closure after débridement was carried out in 131 cases. Primary healing was obtained

in 102. There were 11 mild and 4 severe soft tissue infections. Three of these patients developed gas infections which resulted in death. There were 8 cases of osteomyelitis. Three amputations were carried out, 1 for gas infection and 2 for sepsis with impaired circulation.

#### CONCLUSIONS

1 Double pin skeletal fixation was carried out in 259 of 509 fractures of the leg, to the exclusion of all other operative measures.

2 These cases were from a City Hospital service with a large proportion of severe bumper fractures, and treatment was carried out by the resident staff.

3 Complications due to the treatment, i.e., pin infections, have been lower than would have been expected in a similar series treated by direct operative reduction and internal fixation.

4 Thorough débridement and copious irrigation have been applied to compound fractures. Orr treatment has been reserved for old wounds, recent wounds have been closed primarily without drainage, with interrupted sutures to the skin only, avoiding the introduction of ties or sutures below the skin. This has proved to be a satisfactory procedure.

5 Subcutaneous drilling of fragments has been effective in cases of delayed union.

#### REFERENCES

- 1 GRISWOLD, R. A. Major fractures of the tibia and fibula. *Surg., Gynec. & Obst.*, 1934, 58, 900-902.
- 2 Idem. Fracture of both bones of the leg. *J. Am. M. Ass.*, 1935, 104, 35-38.

# REPORT OF SYMPOSIUM ON METALLIC FIXATION IN FRACTURES

BOWMAN C CROWELL M.D. Chicago, Illinois

THE question of the open reduction of fractures with the use of metallic fixation was discussed at the meeting of the Fracture Committee of the American College of Surgeons held in New York 1938

In opening the meeting the chairman Dr Frederic W Bancroft, stated that he felt that the Committee had the opportunity to do something constructive in the matter of operative fixation, with particular reference to the metals used for fixation. The paper for discussion was presented by Dr Charles S Venable of San Antonio Texas and dealt with the electrolytic action of various metals in the tissues and its relation to osteosynthesis. Dr Venable viewed this electrolytic action as being the controlling factor in osteosynthesis when metals were used. He stressed the fact that there had been a great deal of difficulty encountered in osteosynthesis by metallic fixation, with many serious complications and many inconsistencies in results. In keeping with this he felt that there was a wide difference of opinion on the part of the various investigators. He felt that many of the analyses of the studies had been defective because of the absence of biochemical examinations and felt that use of metallic fixation was essentially to be considered in terms of metal corrosion concomitant with electrolytic action.

Dr Venable then detailed a series of experimental findings. He showed definitely by these experimental findings that when different metals were placed in bone and immersed in Ringer's solution, metallic corrosion due to electrolytic action occurred. He also stressed the fact that in a single piece of metal alloy of the type in which the components of the alloy acted as independent units in the compound similar electrolysis between the various units with resulting corrosion occurred. He stated that such corrosion evidenced an electrolytic action which disturbed bone cells and bone growth and resulted in the loosening of both the plates and the screws.

Dr Venable showed that vanadium steel silver plated steel, nickel plated steel and chromium

plated steel all showed some degree of corrosion in this set up. He stated that when 2 different metals were used such corrosion invariably took place and the existence of difference of potential could always be shown evidencing electrolytic activity. Chromium alloy steel in his experiments showed a similar action. Vitallium was the only metal in his series which remained practically inert under the same conditions as existed when the preceding metals were used. He followed these experiments by similar ones in the living animal in which actual contact with the metals was made with a wire connection through an outside galvanometer, demonstrating the existence of a current passing from one to the other except when vitallium was used. He demonstrated perfectly that of all the metals tested vitallium alone proved practically inert under the conditions of the experiment. He then showed a number of clinical cases in which vitallium was used with no evidence of interference of bone formation or of loosening of the structures and also a case in which a Parham band was used in conjunction with vitallium fixation with resultant bone absorption in the vicinity of the Parham band.

His conclusions were (1) That it is impossible for macroscopic histological or roentgenological studies to determine the reaction of bone to metal (2) that such reaction can be demonstrated only by biochemical studies (3) that when different metals are used the amount of electrical action depends upon the difference of potential of the metals used (4) that in mixed metals or alloys in which the units of the alloy enjoy independent action a similar difference of potential with the creation of a battery action exists (5) that applications containing chromium are particularly troublesome by reason of concentration of electrolytically freed chromium in the liver (6) alloys which are non magnetic entirely resistant to corrosion and which possess sufficient tensile strength should be used for bone fixation (7) experimentally the alloy vitallium made of cobalt chromium and molybdenum is not magnetic and is the only metal known at this time which can be used with consistent results and (8) electrical phenomena are the controlling factors in osteosynthesis with metals.

Presented before the annual meeting of the Fracture Committee of the American College of Surgeons New York February 18 1938

Following Dr Venable's presentation Dr. Colin G Fink, professor of electrometallurgy, Columbia University, discussed the presentation. He stated that as a lay person he assumed that the problem was divided into 2 parts, that of getting mechanically rigid fixation, and that of the behavior and nature of the metal itself. He emphasized the fact that there is always some solubility when metal is in contact with body fluids over a period of time. He felt that Dr Venable's demonstration of vitallium showed that there was not enough solution of vitallium in contact with tissue fluids to create any appreciable electrolytic potential. He stated that his only hesitancy about the alloy was the fact that it was composed of 3 constituents and that under such circumstances it was difficult to reproduce the exact composition at will. Dr Fink stated that if perfectly pure silver could be secured there should be no corrosion in the tissues, and felt that a silver coated steel might be an interesting possibility.

Dr Fink's discussion was followed by the presentation of Mr. Frank, who represented the manufacturers of vitallium. He stated that vitallium had primarily been developed for use in dentistry, and had proved to be electrically inert in the mouth, and had been able to meet all the severe stresses put upon dental prosthesis. He stated that it had absolute resistance to corrosive influences. He also stated that the vitallium alloy used was a single phase alloy in which the fear of interreaction between the components was reduced to a minimum. He compared the corrosive resistance of various metals with that of vitallium and drew the same general conclusions that Dr. Venable had drawn. He stated that vitallium had a high degree of rigidity measured as the modulus of elasticity.

Dr Philip Wilson introduced Captain Daniel J Martin, of West Point, who 2 years previously had tested metals for this committee when they had been attempting to work out a suitable plate. He stated that he believed too much stress was being placed on the point of corrosion inside the body. He did not think that the problem of corrosion should be considered a problem of importance, but that the mechanical properties of the alloy used were much more important. He felt that the chromium-vanadium steel failed not because it was not suitable material to put into the body, but because the heat treatment given before use made it too hard, and sometimes it was cracked in the quenching operation, which accounted for both the corrosive activities and the breaking of plates and screws after insertion into the body. He stated that the stampings on

the plates similarly introduced mechanical faults, and he felt that no pure metal would have the physical properties necessary, and that some kind of alloy was indicated.

Dr Clay Ray Murray next discussed the problem. He stated that the service at the Presbyterian Hospital had investigated the whole question of plates and screws from the standpoint of clinical application. He believed that it was important to consider the purpose for which metallic fixation of the bones was used. If used merely to fix fragments of bone together, to be followed by fixation in plaster, the necessary physical qualities of the metal would be quite different from those required for patients in whom rigid fixation of the fragments sufficient to stand the strain of early, active mobilization without plaster fixation was the object.

He felt that there was no question about the existence of electrolytic action in the tissues. As a matter of fact the mere trauma of operation is sufficient to set up a difference in potential of as high as 100 millivolts between the injured tissue and the adjacent normal tissue. One of the problems for consideration is whether the plate intensifies or prolongs that reaction. In the studies at the Presbyterian Hospital, in which was used a system employing Corning glass Quin-Hydrone electrodes inserted directly into the tissues, he had become convinced that the degree of calcium deposition at the site of fracture was dependent upon the extent of ionization present in the tissues at the fracture site. So long as an acid hydrogen ion concentration existed at the fracture site no calcium deposition occurred. It was of interest that lack of rigid fixation produced acidity at the fracture site due to a mechanical inflammatory reaction regardless of the type of fixation. He had discontinued the use of vanadium steel not because of any reaction in the tissues sufficient to interfere with bone formation, although unquestionably reaction did occur, but because in his experiments vanadium steel was too hard to stand the stresses and strains placed upon it when used as the sole means of fixation under normal body strains. A bone in a living individual is to be considered as under constant vibratory stress due to alternations in muscle tone and to intermittent bending, and torsional and shearing strains due to normal muscle efforts. No tests, which depend upon the ability to bend a metal numerous times at right angles, reproduce the strain the metal is subject to when placed rigidly fixed across a fracture site. Dr. Murray with Captain Martin believed that within reasonable limits the mechanical factors implied

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# CONFERENCE ON TRAUMATIC SURGERY

## THE MEDICAL CONTROL OF SILICOSIS AND TUBERCULO-SILICOSIS

LEROY U GARDNER, M D, Saranac Lake, New York

**M**EDICAL control of silicosis in the United States today is largely in the hands of industrial physicians experienced in the diagnosis of the particular forms of the disease produced in their respective plants. By means of pre-employment examinations these physicians have an accurate knowledge of the physical condition of each new workman entering the plant; from frequently repeated, periodic examinations they have an opportunity to observe the evolution of at least the early phases of reaction to inhaled dust. By studying the older employees, who worked in these same plants before the introduction of programs of dust prevention, these doctors have become familiar with the more advanced stages of these diseases, and they also have at their command accurate data upon the degree and character of atmospheric pollution in different parts of their plants. By correlating these data with their medical findings, they have drawn reasonably reliable conclusions as to the hazard from breathing dusts of varying silica content. Some of these conclusions are still tentative and may be altered in the light of subsequent experience and the introduction of improved methods of examination.

As a result of their individual observation in different plants certain principles have been formulated which now govern the medical control of silicosis and related conditions. Although variations in the anatomical form of the disease and in the degree of associated disability may be created by inhaling silica in various combinations with other mineral dusts, and by the diversity of processes producing dust in different plants, these general principles seem to be applicable to all industries.

Three of these observations are of fundamental importance. (1) The diagnosis of silicosis is based upon 3 factors: (a) evidence of disease in the lungs demonstrated in roentgenograms, (b) a history of

exposure to silica dust, *adequate to produce such disease*; (c) a physical examination to determine the presence of infection and disability. (2) The major cause of disability is not the tissue reaction produced primarily by the inhaled dust, but pulmonary infection which so frequently accompanies such reaction. (3) The degree of disability is not proportional to the extent and severity of the anatomical changes observed in the roentgenogram. Disability can be measured only by observation and physical examination of the workman.

### TYPES OF LESIONS

The pathological lesions of silicosis in pure form and silicosis with infection have been divided into 4 major categories. Since each type presents a different clinical picture and requires different administrative treatment, these 4 types will be discussed individually.

1 A pulmonary reaction characterized anatomically by accumulations of dust-filled phagocytes and proliferation of cellular connective tissue in the larger septa and trunks, and roentgenographically by exaggeration of the linear shadows chiefly cast by the blood vessels, may be due to a variety of causes. Such appearances may be a manifestation of beginning silicosis, in which case they may later progress to the stage of parenchymatous nodulation, but they may also be due to the inhalation of non-silicious dusts which produce only linear reactions without further progression. Furthermore, the roentgenographic appearances of certain chronic infections of the lungs and the pulmonary changes associated with cardiovascular disease of certain types may closely simulate the picture produced by dust. Only a thorough study of the individual and his occupational history can possibly reveal the cause in a particular case. The roentgenographic appearance of linear exaggeration is rarely associated with disability. When it is, other causes must be carefully excluded before attributing the clinical findings to the pulmonary condition. Since linear exaggeration in the pulmonary roentgenogram may be due

From the Saranac Laboratory for the Study of Tuberculosis Presented in the Symposium on Industrial Medicine and Traumatic Surgery, before the Clinical Congress of the American College of Surgeons, New York, October 17-21, 1938



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He asked Dr Hudack who had carried out some experimental procedures, to present his evidence. Dr Hudack stated that the metal used should have resistance to surface corrosion and resistance to fatigue failure. Vanadium steel under the vibratory stresses described had suffered intermolecular corrosion as the result of fatigue strain, making it liable to fracture. The same thing did not happen when a solid solution of the 3 phase high chromium low nickel steel was used. It was also found that stamping and casting both impaired the necessary physical qualities of the metal. In addition it was found that a non abrasive polishing of the surface was necessary. He also stated that a minimum degree of corrosion was much less important than these physical qualities. Preceding the non abrasive polishing of the surface a passivating of the surface by the use of an acid bath was indicated. Microscopic section of the tissues a year after the

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The results of the whole conference would seem to indicate that the 2 factors, first, the composition of the metallic fixation used and second the rigidity and adaptability of the fixation used to physical strains and stresses, probably represent the basis of a possible solution to the question of operative fixation.

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infections. Since such lesions are most frequently discovered in persons exposed to mixtures of silica and other minerals, the latter may play an *etiological rôle*. Regardless of their cause all such lesions are complicated by emphysema and this reaction is responsible for the cardinal symptom of dyspnea.

The severity of the dyspnea limits the capacity for work and usually compels retirement. Many old employees, who suffer from this condition are permitted to perform light work about the plant, which they may prefer to retirement on pension. Discharge becomes obligatory only in cases where the massive fibrosis is due to associated tuberculosis, which has become active and is shedding tubercle bacilli in the sputum. The methods of detecting this outcome logically belong in the next category.

4 Tuberculosis is the most important infection of the lungs to be considered in the silicotic subject. Bronchopneumonias of other origin may present difficulties in diagnosis but, as they generally run a chronic course and produce results comparable to those provoked by the tubercle bacillus, they will not be discussed.

Tuberculosis associated with silicosis may manifest itself in typical form in which case it offers no particular problems of diagnosis or administration. The discovery of active or questionably active foci of this infection in pre-employment examination obviously disqualifies an applicant for work in a silica industry. Ample experience indicates that long-continued inhalation of silica dust may reactivate such latent foci and produce chronic disease. Apparently healed foci of tuberculosis offer greater problems. In young applicants, whose foci are more likely to be of recent origin, it is unwise to permit the risk of reactivation. Some authorities apply this dictum not only to apparently healed foci of reinfection in the pulmonary apices but even to the calcified foci of primary infection that generally occur in childhood. While most of the latter lesions are completely healed and sterile by the age of employability, a few cases of reactivation have been observed. In experimental animals reactivation has been proved possible in any focus still containing living tubercle bacilli. A reasonable policy would permit employment of all persons of mature age with roentgenographic evidence of small calcified primary foci. If the subject were young and his primary tubercle were large or exhibited any other suggestion of incomplete healing, he should be rejected, at least temporarily. In the periodic examination the discovery of a new case of typical tuberculosis in a silicotic subject demands

the same procedure as in the general population, i.e. immediate treatment.

Unfortunately the majority of tuberculous complications in silicotic lungs are not typical and present serious problems in diagnosis. Such conditions fall in 2 categories, 1 an acute manifestation and the other characterized by unusual chronicity.

Acute tuberculosis is quite as rare in silicotic groups as it is elsewhere. Since the victims are prostrated by symptoms of intoxication, they would hardly be a problem in the pre-employment examination. If the periodic examination of a workman, whose films previously revealed generalized, discrete nodulation, discloses a marked increase in the size of the nodular shadows with loss of their ordinarily sharp definition, one should suspect infection. If in addition the film presents a new ill-defined but localized shadow, perhaps in the upper portion of the lung, the probability of tuberculous complication is even greater. Usually, if the man himself has not volunteered a complaint, questioning will reveal symptoms and he may even have some fever. Obviously he needs prompt hospitalization with the usual treatment. Such cases tend to run a rapid course and most of them terminate fatally within 6 to 12 months.

The chronic aspects of tuberculosis in the silicotic subject have already been mentioned in connection with the massive types of simple silicosis. The questions raised in section 3 remain to be discussed. If the localized lesion is due to some cause other than an active infection, it is classified as one of simple silicosis. If it results from an infection that is still active but encapsulated and latent, it should be classified as tuberculo-silicosis.<sup>1</sup> This is a new condition and not merely a superimposition of an element of infection upon a background of silicotic fibrosis. It apparently results from the simultaneous action of silica and relatively few tubercle bacilli barely able to survive in an environment of avascular scar tissue. It may produce no symptoms of intoxication and no bacilli in the sputum for many years because the investing scar tissue prevents absorption of toxic products and the excretion of tubercle bacilli. Late in life, however, the infectious element usually becomes dominant, symptoms of infection are manifested, bacilli reach the bronchi and are expectorated, and frequently the fibrous area breaks down to form a cavity.

<sup>1</sup>The writer has previously employed the term, "silico-tuberculosis," to describe the same condition. At a recent meeting of the Correspondence Committee on Silicosis of the International Labor Office it was urged that in conformity with South African usage the order be reversed. In compliance with this request for international uniformity in terminology, the condition in the future will be referred to as "tuberculo-silicosis."

to so many causes, it is impossible to state whether associated tuberculosis or another infection in a particular individual is due to the underlying anatomical change. Among groups of persons employed only in industries creating highly silicious dusts, the incidence of pulmonary infection may be moderately increased in individuals showing linear exaggeration. However, the increase never approximates the percentage observed in persons with specific nodulation of silicosis.

It is generally customary to accept for employment in a dusty industry any applicant whose film reveals slight or moderate degrees of linear exaggeration. Men with very marked changes of this type whose occupational history suggests considerable previous exposure to silica dust will be rejected by many examiners. It is debatable whether this attitude is justified except in the case of young individuals under 30 or perhaps 35 years of age. In applicants over 40 who have already been exposed for 15 or 20 years the condition is much less likely to progress particularly in an industry where the engineering methods of dust control are effectively applied. The discovery of linear exaggeration upon periodic examination of persons already employed demands no action unless the condition is developing rapidly in young individuals. This rather rare occurrence is probably best met by transfer to another department of the plant. Otherwise no change in occupation is indicated, compensation rarely enters the picture owing to the lack of disability and consequent wage loss.

2. Dust reaction characterized anatomically by the formation of discrete fibrous nodules, not over 6 and usually not over 4 millimeters in diameter, uniformly distributed throughout all parts of both lungs and roentgenographically by the picture known as nodulation (discrete shadows of the above size and distribution) is most likely to have been caused by inhaling free silica. A history of adequate exposure to such dust together with a physical examination usually establishes the diagnosis with reasonable certainty. Only a few rare fungus infections, certain tumors and very unusual cases of cardiovascular disease produce similar patterns in the pulmonary roentgenogram. Discrete nodulation is uncommonly associated with sufficient disturbance of pulmonary function to impair the capacity for habitual work. In advanced cases, which are usually complicated by emphysema, dyspnea on exertion is a common symptom. The individual with generalized discrete nodulation is definitely more susceptible to tuberculous infection and to bronchopneumonia of other etiology than a normal subject. The same

is not true for lobar pneumonia. Although this increased susceptibility to infection makes the silicotic workman a potential liability, he is usually capable of productive work until such infection develops.

Pre-employment examination often unjustly prevents persons with simple discrete nodulation but no disability from obtaining work. In periods of labor shortage, however, skilled workmen with such manifestations of silicosis have been accepted and have rendered efficient service. Provision in the compensation laws to relieve employers of full responsibility for any infection which might develop subsequently, would overcome their natural reluctance to hire such men and would permit most silicotics to be self supporting. In the periodic examination of persons already employed in a silica industry the discovery of early, simple, discrete nodulation does not justify discharge. Significant degrees of disability will not be manifested in the absence of infection, and in industries with effective dust prevention programs the silicosis will progress with equal rapidity regardless of continued employment. Only the young individual who has developed silicosis at an early age, need be transferred to another job because his naturally greater susceptibility to tuberculosis might be augmented by further exposure to silica dust. Perhaps the most important function of the periodic examination is the early detection of evidence of pulmonary infection. Such cases must be given the benefit of prompt treatment and removed from positions where they might endanger fellow workmen with silicosis. They will be considered in section 4.

3. Dust reactions characterized anatomically by areas of massive, conglomerate fibrosis with or without an associated discrete nodulation present the greatest problems in diagnosis and administration. The pathological anatomy of such lesions consists of large areas often bilateral composed of great numbers of nodules embedded in a matrix of diffuse fibrosis which more or less completely obliterate the normal pulmonary architecture. Other parts of the lungs usually exhibit small, discrete, isolated nodules but these may be absent. Almost invariably the so called 'conglomerate fibrosis' is associated with well marked emphysema often of the bullous type. The causation of such lesions is not well understood. Some of them are unquestionably due to low grade infections which produce no toxic symptoms for long periods of time. Others in the writer's opinion are the result of excessive accumulations of silica dust in the scars of healed

# METHODS OF INVESTIGATION OF OCCUPATIONAL SKIN DISEASES

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**I**N order to investigate intelligently the cause of occupational dermatoses, one must have at least a sufficient knowledge of dermatology to distinguish contact dermatitis from such ordinary skin diseases as psoriasis, impetigo, urticaria, pityriasis rosea, etc. In addition, one should also have a fair knowledge of chemistry. The actual investigations in factories will give one the knowledge of industrial processes which is also an essential requirement.

Before we can hope for success in finding out the cause of a particular outbreak of occupational dermatitis, we must have the experience and knowledge gained by studies of the normal skin hazards and the normal incidence of occupational dermatoses in the basic industries. Such studies not only acquaint us with the irritating properties of various chemicals and compounds, but often lead to the discovery of health hazards not previously reported. It was in the course of such routine studies that we first noted the health hazards connected with the manufacture and use of certain chlorinated hydrocarbons and certain synthetic resins.

The basic industries are selected for routine studies, because they manufacture the chemicals used in all other factories, and their workmen are subject to the hazards of contact with these chemicals. We also make it a practice to scan the reports of occupational dermatoses which are submitted to the Public Health Service by the Compensation Boards of the various states, and we note if there is any unusual occurrence of occupational dermatoses in any one factory. If there is, we investigate its cause.

To gain entrance into factories to make our studies, we first awaken the interest of the owners or management to the importance of our work. This is done by means of letters and interviews in which we assure them that our studies are conducted in such a manner as not to alarm the workers or to inconvenience the routine of the factory, and that the results of our investigations will in no way hurt their business, but, on the contrary, will help to lessen the health hazards among their

workers. After such interviews permission to make the investigations have always been granted.

In proceeding with an investigation, the first step is to discuss with the plant superintendent the occurrence of occupational diseases, especially those of the skin, which to his knowledge had occurred in the factory, to obtain from him a list of the raw materials used in the factory and of the products manufactured. The next step is to consult with the plant physician, if there is one, or with the nurse or first aid attendant, concerning the chief infections or diseases treated in the dispensary, and to obtain from them a little better conception of the incidence of skin diseases than was obtained perhaps from the superintendent. The medical records, if any have been kept, are then examined regarding the number of cases of skin lesions treated, the departments in which the patients worked, and the causes given for their occurrence. This procedure often yields a clue as to what part of the factory has the greatest skin hazards. It is also well at this time to request that such of the workers, who have had occupational skin diseases or who are known to be affected at the present time, be called into the dispensary to be questioned and examined. This enables us to check and evaluate the criteria used by the plant physician in making a diagnosis of occupational dermatitis.

We then request the superintendent to appoint someone familiar with all the industrial processes in the factory to escort us through the plant. In many instances he himself, together with the plant physician, accompanies us in our inspection. We begin at the point where the raw materials come in and follow them through the plant until the finished product is ready for shipment. In each department visited we first interview the foreman, asking him if he knows of any workers who have now, or ever have had skin diseases, and what in his opinion caused these diseases. We then go through the department and have the manufacturing process explained to us. We examine the hands and faces of the workers for skin lesions, at the same time taking note of their work clothes, whether they are clean or dirty, and whether protective clothing in the form of gloves, aprons, boots, respirators, etc., are worn. We

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The industrial physician's problem in diagnosis is difficult. As long as the infection remains dormant the workman is not a menace to his fellows; he may not be seriously incapacitated though more or less short of breath, and he may wish to continue at his job. It is probably just as well that he should for no form of treatment up to the present time has cured such a disease so far advanced. If the employee's temperament is such that he is happier at home, he should be retired on compensation but permitted to perform light jobs.

If he is kept under observation, it is not always easy to determine when his tuberculo-silicotic lesion is about to break down and become a menace to other employees. Systematic records of body weight are kept; a progressive loss suggests the need for further investigation. Repeated roentgenograms may reveal a change in the size or the character of the localized lesion and perhaps evidence of extension in the surrounding lung. Examination of the sputum for tubercle bacilli requires patience as many negative reports must be anticipated; persistence will usually yield positive results. Guinea pig inoculation or culture are preferable to direct methods of examination as the number of organisms is small when they first make their appearance.

At the first indication of clinical or bacteriological activity the workman with tuberculo-silicosis should be removed from contact with other silicotics. In some plants special isolated jobs, involving little or no physical effort, have

been created for them. Hospitalization and any of the forms of treatment applicable to uncomplicated chronic tuberculosis have had little effect upon this condition. Intelligent cooperation with a minimum of physical effort may prolong life but it cannot cure the disease. Since this is usually most difficult to obtain from men of this class there is need for research upon new means of therapy. Today one can only hope that modern programs of dust prevention will preclude the development of tuberculo-silicosis in the new generation of workmen.

From the foregoing discussion it is obvious that uncomplicated silicosis usually produces too little disability to disqualify a workman for his habitual occupation. The supervention of tuberculosis or other infections of the lungs are largely responsible for decreased capacity to work and are the ultimate cause of death in many silicotic subjects. Therefore, it should be the major objective of the industrial physician to protect his silicotic charges from contact with the tubercle bacillus. The methods which he employs inside of the plant have already been indicated but his responsibility does not end here. He must also extend his supervision into the home and the community at large. By cooperation with the public health authorities programs of case findings and education should be encouraged. Every hospitalized case of open tuberculosis in an employee reduces the possibility of a disabling infection in an industrial physician's plant.

While outbreaks of occupational dermatoses usually occur in only one department of a factory, it is necessary to study not only that one department, but the whole process of manufacture, or at least all of the processes which precede the one in which the outbreak occurred. We should study the sickness records of the plant for at least 1 year previous to the outbreak, in order to determine whether the outbreak occurred suddenly, or whether there was a gradual increase in the number of cases of dermatitis, and whether there was any connection between a sudden increase in the incidence and the use of new chemicals, new processes, or changes of old processes in the factory. Detailed inquiries should be made of the superintendent, the foreman, and the workers as to changes in manufacturing processes and the introduction of new chemicals preceding the outbreak of dermatitis.

Patch tests should be performed with all of the materials handled by the affected workers in an effort to track down the offending substance. In some instances the management purchases, under trade names from other concerns, the chemicals which they use and do not know their composition. It is necessary in these cases to trace the chemicals to their original source of manufacture and thus determine what they really are.

By way of illustrating how such outbreaks of dermatitis are studied, I will outline a few actual investigations which we made.

#### SPECIFIC INVESTIGATIONS

**CASE 1** We were requested to investigate an outbreak of dermatitis in a cotton mill. It was found that the lesions occurred only among those workers whose forearms came in contact with new heddle frames in the weaving machines. The skin of the forearms touched by the heddle frames was first affected. The frames were made of spruce and were painted with a yellow, waxy varnish. Patch tests with the varnish scraped off the frames gave positive reactions, while patch tests with the wood itself gave negative results. Removing the varnish from the heddle frames checked the occurrence of dermatitis. This definitely established the fact that the varnish on the new heddle frames was the cause of the dermatitis.

Wanting to ascertain what in the varnish caused the dermatitis, we visited the manufacturer of the frames. There it was found that the varnish on these frames was purchased from a different paint factory than was the varnish which had previously been used and which had caused no dermatitis. The new varnish was introduced because it produced a smoother and a more waxy finish on the heddle frames. It was learned that some of the workers in the heddle frame factory, who were engaged in applying the new varnish, also contracted dermatitis. Letters to the other cotton mills, which had purchased the same new heddle frames, brought out the fact that cases of dermatitis had occurred also among their workers since the installation of the new frames. The makers of the varnish were then visited and the ingredients of the varnish obtained. These were taken back to the first cotton mill, reporting the out-

break, and patch tests were performed with all of the ingredients in the varnish on those workers who had suffered with dermatitis. It was found that chlorinated ceresin, a wax, was the chief irritant. Patch tests performed in other cotton mills confirmed the results obtained in the first mill. The chlorinated ceresin produced a smoother, waxy finish to the varnish, but under the atmospheric conditions, usually prevailing in cotton mills, the workers perspire freely and the perspiration, coming in contact with the wax, caused the formation of hydrochloric acid which was the actual cause of the dermatitis.

While patch tests are a great help in determining the causes of occupational dermatitis, it is not always possible to use them and we must sometimes devise other methods of approach. The following is an example of this:

**CASE 2** An outbreak of dermatitis among cable splicers occurred in Chicago and in New York City simultaneously and in no other place, although the process of cable splicing is the same in all parts of the United States. After several unsatisfactory attempts by others at determining the actual cause of this outbreak, the telephone company referred the problem to the Public Health Service.

The workers affected had been patch tested by previous investigators and at first refused to submit to any more such tests. Therefore, we decided to divide the operation of cable splicing into 7 stages and to have the workers, who had been affected and who were now well, work a number of days on each stage then rest a few days before taking up the succeeding stage. In this way, we hoped to find out at what operation in cable splicing the dermatitis actually occurred.

It was found that the dermatitis occurred during the operation of "boiling out" the green and blue, paper-wrapped wires in the cables. The "boiling out" was done with a mixture of paraffin and mineral oil, and was done for the purpose of removing all moisture from the wires. The dyes used on the green and blue papers were malachite green and methyl violet. Although some of the stages of operation consisted of "boiling out" other colored wires with this mixture, no dermatitis occurred from splicing wires dyed any other color, nor did it occur from the "boiling-out" mixture itself. Patch tests performed with strong concentrations of the two dyes produced dermatitis in some of the workers. By the time that we had reached this stage of our study the workers had become so interested that they consented to our patch testing experiments.

Further experiments showed that in the process of "boiling out" the dyes were partially decomposed, and that the decomposition products were dissolved in the "boiling out" compound. The "boiling-out" compound was used over and over again, and in this way it contained a high percentage of decomposition products which were carried off in the fumes and irritated the skin of hypersensitive workers. The reason that the outbreak occurred at that particular time in Chicago was that there was a large amount of cable splicing being done for the Chicago Fair and the workers were unusually exposed to the fumes of the "boiling-out" compounds, while in New York, at about the same time, new cables larger than any that had been laid before were being installed and this entailed an unusual amount of cable splicing. As a result of these experiments new dyes were satisfactorily substituted for the old dyes in the manufacture of telephone cables.

**CASE 3** Recently we were requested by an insurance company to investigate dermatitis occurring among workers in a factory manufacturing conduits made of paper



note the cleanliness of the work room, whether there are any safeguards on the apparatus such as ventilating hoods etc., and ask each worker if he now has or ever has had any skin diseases. The names of workers, who are found to be affected with skin lesions or who state that they have been affected at some time or other are taken, and at the end of the day's inspection these workers are summoned to the dispensary and examined further.

The primary inspection of the men at work takes but a short time—not over half a minute for each man. The same procedure is followed in every department, and notes concerning the industrial processes and hazards are taken. At the end of the day's inspection usually an hour or so before the end of the day's shift, we go to the first aid room and send for the workers found during our inspection to be affected with skin diseases. Such workers are examined one at a time with only the plant physician, nurse, or first aid attendant present. The worker is required to disrobe completely and his body is examined for the presence of skin diseases. It is important to strip the patient, because often an important clue to the diagnosis is revealed which might otherwise be overlooked.

A card record is made of the patient noting the name, sex, age, color, and a detailed description of the worker's occupation, giving the chemicals with which he comes in contact. The date of entering on his present occupation is noted as is also a history of his previous occupations. A record is made of previous skin diseases and of any allergic history. A detailed account of the present skin diseases is taken putting down the date of onset and the symptoms, a written description of the skin lesions and their location is made on the card, the patch tests if any are performed are also described, giving the names of the chemicals applied as patches, the length of time they are allowed to remain on the skin and the resultant reactions. Based on this data the diagnosis is made and the actual skin irritant if found is named. Under the heading Remarks we record complicating skin lesions and the treatment advised.

#### CRITERIA FOR DIAGNOSIS

The following criteria are used in making a diagnosis of occupational dermatoses.

1. *History* This should bring out the fact that the dermatitis was not present before the patient entered on his present occupation and that it developed during a period of industrial exposure or after a lapse of a reasonable period since the cessation of exposure.

2. *Site of eruption* The eruptions must have begun first on the exposed parts, usually the hands, fingers and forearms, if the offending material is a solid, or a liquid and on the face and neck, if the offending material is a vapor. However, in the case of irritant dusts, which may penetrate the clothing the covered parts of the body may be affected first, especially if the clothing is not frequently changed. Sometimes the points of friction, such as the wrists where the ends of the gloves and sleeves rub, or the belt line where the belt or the top of the trousers cause friction, are the first affected.

3. *Characteristic appearance of lesions* An acute industrial dermatitis begins as an erythema followed by papules, vesicles, and crusts no matter what the irritant may be. It must be remembered however that there are a few classes of industrial irritants which produce more or less characteristic lesions on certain parts of the body such as paronychia which is a common lesion among fruit and vegetable canners. Acnes are common lesions caused by chlorinated waxes, petroleum oils, and coal tar folliculitis and boils are often produced by dirty clothes and oil and keratosis and malignant growths are caused by coal tar, certain petroleum, and arsenic.

Patch tests are an important diagnostic procedure but they must be performed by someone familiar with the technique and who will not patch with primary irritants, otherwise they may lead to wrong conclusions. Before patch tests are performed on the workers, the object of performing them must be explained to them and their consent obtained, otherwise legal complications may develop.

Differential diagnosis is often difficult, but a rule that applies in many instances is that dermatitis, due to occupation tends to get well when the patient is removed from his work, and recurs after the patient goes back to his same job.

When a number of factories manufacturing the same products have been examined a fair idea of skin hazards in that particular industry is obtained. The knowledge and experience gained by routine studies of industrial processes and skin hazards in basic industries prepare us to understand intelligently the investigation of the causes of outbreaks of occupational dermatoses. The requests for such investigations come from insurance companies, the managements of factories and labor unions. Such outbreaks of occupational dermatoses usually occur when new chemicals are introduced or when new manufacturing processes are being installed or when there is some change made in old manufacturing processes.

# THE DIAGNOSIS AND THERAPY OF SO CALLED POSTTRAUMATIC NEUROSIS FOLLOWING CRANIOCEREBRAL INJURIES

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**P**OSTTRAUMATIC neurosis, posttraumatic state, compensation neurosis, postconcussional state or neurosis, litigation neurosis, traumatic hysteria and malingering are all common and interchangeable terms. They are used to describe a group of symptoms which pester patients, doctors, insurance companies, and law courts and which develop after the patient, who has received any craniocerebral injury, has left the hospital or its equivalent. They imply conscious or unconscious attempts on the part of the victim to prolong unduly his period of invalidism and suggest a non-organic rather than an organic basis for his complaints. There have been, and doubtless always will be individuals, who, after being hurt, give false testimony, and intentionally magnify minor injuries in order to obtain more money or other compensation than they are justly entitled to.

However, it is neither fair nor correct to conclude on that account, that all patients who have had head injuries in the past, and who, at some later date, complain of disabling symptoms, that cannot be shown by ordinary tests to be due to objective changes, should be classified with this unsavory minority. For example, LeFever and Secrest have shown that of 100 patients injured in industry and later proved to have objective signs of brain abnormalities 71 per cent had complained at first chiefly of headaches, 64 per cent of dizziness, and 43 per cent of tinnitus. The usual tendency of the medical profession to avoid the middle ground of reason and to take the attitude that such individuals are either the blackest sinners or the most spotless saints, justifies a consideration of the diagnostic and therapeutic possibilities of this problem. Only those patients, who continue to complain of symptoms referable to the head after they have been active a few weeks, are included.

## DIAGNOSIS

When a physician is confronted with the necessity of making a diagnosis of a man who attributes

headaches, inability to work, lassitude, dizziness, and the like to an antecedent accident, it is obviously of the first importance to be sure that he did, in fact, injure his head as he claims. To do this, it is only necessary to demonstrate a period of unconsciousness or its lay equivalent, and/or a period of severe headaches immediately or shortly after the accident. Confirmation may be had by scars on the scalp and, of course, by x-ray evidence of bone damage of appropriate age. The usual and best evidence for or against this claim will be historical, however. In collecting it, the doctor should stay away from the legal or controversial aspects and content himself with obtaining those facts which can be verified by associated objective evidence. He should never accept the patient's own story without such confirmation as is obtainable from a description, or a lack of it, of the details of the periods immediately preceding and following the accident as well as those of the accident itself. These can and should be checked by independent witnesses or by the demonstration of such incontrovertible facts as the state of the weather, the road, the job, and the like.

Having satisfied himself that his patient has actually or probably been the recipient of a craniocerebral injury, the physician is justified in concluding that the symptoms about which the complaint is being made may be due, among other things, to the late effects of this damage. However, this conclusion cannot be final until other possible causes have been ruled out. The patient may, for example, have had an intercurrent disease, the presence of which is unknown to him, and which has no relationship whatever to the head injury, but which is actually producing symptoms that mimic those commonly seen as some of the late results of the previous accident. Even should this be considered a far-fetched possibility, the physician still must learn whether or not there is present evidence of continuing cerebral or cranial pathology. To get all this data, the patient who would learn the cause of his post-traumatic syndrome or who would be relieved of his symptoms must submit to hospitalization.

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impregnated with coal tar pitch. Men working inside the factory were not affected but those working in the yard where the finished conduits were stored suffered considerably with dermatitis. Previous investigations resulted in no satisfactory explanation. A visit to the factory was made and on examination of the workers brought out the following facts:

All the workers exposed to the fumes and dust of the coal tar pitch whether in the yard or inside the plant had a marked melanosis. The workers in the yard suffered with dermatitis especially on bright days similar to a severe sunburn. The workers inside the factory stated that they too suffered more from sunburn on their days off from work than those employed elsewhere. Patch tests performed with coal tar pitch dust gave no reactions upon removal of the patch but upon exposure of the patch area to sunlight there developed a marked sunburn. This showed that exposure to coal tar pitch sensitized the skin to light. Examinations of workers in other factories making conduits where there was an exposure to coal tar products revealed the same conditions. This was the first time that occupational photosensitivity was reported in America. Effective preventive measures were devised.

Because of the experience we have gained in making studies of industrial processes and the skin hazards connected with them we are often called upon to investigate the causes of outbreaks of dermatitis occurring among the users of manufactured goods. The following will illustrate this:

**CASE 4.** A certain manufacturer of wrist watches decided to use jet black sweat proof straps on his products. He ordered such straps from a leather strapmaker. After about 100,000 of these straps had been sold to stores complaints and law suits began to come in because of dermatitis on the wrists of the wearers of these watches which had been caused by the leather straps. The straps were

sent by the watchmaker to a leather research institute and to a well known dermatologist to determine if they contained a skin irritant. Reports from both were negative. Before contesting the suits for damages however someone in the factory suggested that a number of the workers be asked to wear the straps as an experiment to see if any of them would develop dermatitis. Accordingly, 50 workers volunteered and were given the straps to wear and in a few days 6 of them had developed a dermatitis of the wrists. The Public Health Service was then requested to investigate.

We visited the manufacturer of the straps and learned from him the source of the leather and of the dyes. We obtained samples and patch tested the workers who had worn the wrist watch straps with the undyed leather the dyed leather, and with each of the chemicals used in the dyes. Positive reactions were obtained only from the dyed leather and from one of the dyes used in the dye mixture. This dye is known as butter yellow and has the chemical name of amido-azo-toluene hydrochloride and had never before been reported as a skin irritant. In fact it was thought to be so innocuous that it had been used to color some edible fats. We found that the yellow dye was mixed with the black dye (nigrosine) in order to give the straps a jet black color instead of the blue black color imparted to the straps if only nigrosine was used. Elimination of butter yellow from the dye mixture stopped the dermatitis caused by the wrist watch straps.

We have had similar experiences with fabrics, paints and cosmetics.

These are in brief the methods of investigation which we adopt in studying the causes of occupational and other forms of contact dermatitis. All of the investigations and problems of contact dermatitis are interesting, instructive, and fascinating, and some of them will tax the ingenuity of clever chemists, allergists and dermatologists.

will deprive him of the use of any alibi for a failure to improve, that is based on the doctor's directions. Such a requirement will also set the stage for his psychological rehabilitation, the chief essential of which is to force him to assume full responsibility for all his actions. Thus, he will govern the speed with which he recovers and is able to return to his normal way of life, insofar as his permanent anatomical disabilities will permit him. Necessary adjuncts to this regimen are that he shall not see his doctor except at infrequent intervals, that his return to work shall, if possible, await his own request, and, that when he does return, he shall be started in on a job that does not require the use of his full physical capacity, even if this means a shift in work or temporary, half, or part-time employment.

Unfortunately, only a minority of patients that have had craniocerebral injuries suffer at this later date from organic abnormalities that have been missed previously and that can be demonstrated objectively. Usually, all objective tests are entirely normal and all symptoms exclusively subjective. All that the doctor has learned from his study of the patient is that at some designated time in the past, he did sustain a head injury and that now he shows no objective evidence of disease or injury. If the patient or those concerned with his welfare want more diagnostic data, he must accept the necessity of undergoing further, more complicated diagnostic procedures. These, because they carry a minimal but inescapable risk, cannot be forced upon him. If he elects not to take this further step, the doctor can do no more than inform him that at that time no objective evidence of disease or injury can be elicited as a cause for his subjective complaints. Hence, his symptoms may be due to neurosis, malingering, a subdural hematoma, cerebral atrophy, or psychotic maladjustment, and, because no certain differentiation can be made without further studies, no reliable advice as to treatment nor statement as to the future can be given. Such an opinion, being based upon demonstrable facts, can be supported in the face of hostile argument where traumatic neurosis and its synonyms will let the doctor down because of its vagueness and the implications of malingering that inevitably accompany it.

#### SUPPLEMENTARY DIAGNOSTIC PROCEDURES

If the patient or those responsible for him elect to go further in their efforts to rid the patient of his symptomatology, there are 2 supplementary procedures that are open to him. Both have a slight but inescapable risk and, therefore, cannot

be carried out without his specific consent. This permission should be written and should be used only after the doctor has satisfied himself that the patient, his family, and any other interested parties fully understand that this further investigation carries no actual or implied promise of relief and that it is essentially and primarily a diagnostic procedure. As such, it will only indicate what further methods, if any, can be used to promote relief.

The first of these procedures is encephalography. A discussion of its technique and limitations cannot be undertaken here. Suffice it to say that in my clinic encephalography has demonstrated cortical atrophy with a high degree of accuracy, solid subdural hematomas sufficiently often to be a valuable adjunct in their diagnosis, (6) and fluid subdural hematomas and "encysted fluid" not at all. None of these conditions need be accompanied by any objective changes that would necessarily be demonstrable by any of the procedures discussed above. Encephalography has had no value as a method of treating the symptoms of the posttraumatic syndrome. While I have used it at times for this purpose, usually accompanied by suggestion, I do not believe that it is as efficient or reliable as other and more classical varieties of psychotherapy.

The other supplementary diagnostic procedure is exploratory trephination (3, 4, 6). This procedure offers the final opportunity to arrive at the cause of these late symptoms. While its ultimate object is to visualize a part of the cortex of both cerebral hemispheres, its chief and almost exclusive use is to determine whether or not a subdural hematoma is present and acting as the probable cause of the symptoms. This possibility is not so remote as might be imagined. Reference to Figure 1 will demonstrate that subdural hematomas are present in about 1 out of every 5 cases of craniocerebral injury that are hospitalized at the time of the causative accident. The figures are reliable having been verified in each case by operation or autopsy. When it is further borne in mind that the probability of diagnosing and treating subdural hematomas is extremely small, in non-hospitalized patients and in patients that are cared for in the smaller general hospitals during their period of acute illness, it must be apparent that previously unrecognized subdural clots will be even more common among those patients who come in complaining of late symptoms. No figures are available relative to this later occurrence rate, but it may well be that every other one of such patients will eventually prove to be suffering from the more

Requisite information such as here outlined can not be obtained in an office under any conditions and a physician will do much better if he refuse to give any opinion, whether to patient, insurance company, or lawyer, until he is permitted to acquire the facts he needs in the proper way. Indeed, he should refuse to have anything to do with the case under any other circumstances.

Preparatory to a more intelligent estimation of the data that is to be acquired, and after the patient has been hospitalized, it is well to get what details one can relative to the treatment given at the time of the accident. This must, of necessity, have considerable bearing on the occurrence of late symptoms. If we predicate, for example, 2 individuals neither 1 of whom had any significant demonstrable symptoms during the acute stages but who had been hurt in exactly the same way and to the same degree, and in whom a mild contusion and edema of the brain represented the underlying pathology, it should be obvious that the patient whose increased intracranial pressure had gone untreated would and should have greater permanent cellular destruction in his brain. If both these men happened to be compensation cases and complained of an inability to work 3 months after the injury or had post-traumatic" or "compensation neurosis" or were accused of "malingering" an organic lesion which was compensable could unquestionably be ascribed to the 1 who received improper or no treatment while the other who had received proper and adequate therapy, should be regarded with suspicion. Yet, the late symptoms are present in the first patient in part at least, because of his doctor's failure to base his diagnosis on demonstrated pathology and because of his belief that a lumbar puncture wasn't necessary since the patient didn't complain. It is this same fundamental inexactitude which leads to a diagnosis later of "postconcussional neurosis" when the patient's original injury was a lacerated brain, and despite the fact that concussion by definition is a self-limited disease and can have no aftermath. Thus there should be available in every late case of craniocerebral injury data as to earlier increased or decreased intracranial pressure as to the presence of blood in the cerebrospinal fluid reports of ordinary x-ray studies a description of the pathology found in the course of any exploratory operation that was done records of blood pressure changes an enumeration of the number and notation as to the extent of any scalp wounds and the involvement of air sinuses or arterial grooves in fracture lines. These facts will confirm or deny the probability of a head injury as deduced from

the history, and will serve to annotate and help in the interpretation of the physical signs collected during this later hospitalization.

At this late date after the accident the doctor's further aim should be to get a complete picture of the patient's present physical condition. The picture should be based chiefly, however, on an objective demonstration of facts. A physical examination repeated neurological examinations, necessary mental tests, tests of the special senses study of the blood and urine and an estimation of the efficiency of the kidneys, must all be included. Lumbar puncture with a demonstration of the intracranial pressure and chemical, serological and cytological examinations of the cerebrospinal fluid are absolutely essential. An adequate x-ray examination should visualize the bony structures that come under suspicion. Such a procedure is the minimum that permits an inferential opinion as to the physical relationship between the accident in the past and the subject's symptomatology of the present. If the general studies are negative it can be concluded that no intercurrent disease, previously unrecognized, is causing the symptoms which bring the patient to the doctor at that time. The special examinations should eliminate associated mental disease, arteriosclerosis, syphilis, multiple sclerosis, syringomyelia, pernicious anemia, and the like. The lumbar puncture and cerebrospinal fluid studies will rule out an expanding intracranial lesion and the x-ray a previously unnoticed bone injury.

#### TREATMENT

If by these diagnostic methods the surgeon can show that the patient did in fact, sustain a craniocerebral injury as he alleges and that at the time of this later examination there is objective evidence of craniocerebral pathology, the indicated therapy should be provided without further delay. If there is objective evidence of cranial or intracranial abnormality, such treatment will of necessity be operative. A decompression will be required for a high intracranial pressure depressed fractures should be elevated cortical abscesses must be drained and appropriate steps taken to correct such unusual conditions as traumatic arteriovenous aneurysm the presence of bilateral subtemporal decompressions and the like. In addition measures to improve the patient's general condition and psychological reactions should be initiated. For the first a program of graduated increasingly severe exercise interspersed with judicious periods of rest will be found most useful. The patient should be made the sole judge of the rate of increase. This

TABLE II

Interval between accident and operation	Successes	Failures
1-2 mos	4	
2-4 mos	4	
4-6 mos	4	
6½ mos	1	
7 mos		1
8 mos	3	
9 mos	2	
1 yr	2	3
1½ yrs	1	1
2 yrs	3	1
2½ yrs	1	1
3 yrs	1	1
3½ yrs	2	
4 yrs	3	
5 yrs		1
5½ yrs	1	
6½ yrs	1	
13 yrs (birth)		1
18 yrs		1
none		1
	33	12
Postoperative follow-up interval	Successes	Failures
1 mo	2	
2 mos		1
3 mos		1
4 mos	1	
6 mos	1	
8 mos		1
1-2 yrs	6	2
2-3 yrs	10	3
3-4 yrs	4	3
4-5 yrs	7	1
5-6 yrs	2	
Total	33	12
Not traced		2
Grand total		47

TABLE III.

Age	Successes	Failures
Oldest	62	62
Youngest	10	6
Average	28¼	32¼
Occupation	Successes	Failures
Student	13	1
Housewife	4	1
Laborer	4	2
Skilled laborer	5	1
Office worker	3	1
Nurse	2	1
School teacher	1	
Policeman		2
Priest		2
Infant		1
None	1	
Organic symptoms at time of operation	Successes	Failures
None	23*	2**
Aphasia	2	
Mental abnormality	1	4
Convulsions	5	4
Optic neuritis	1	1
Depressed fracture	1	
Hemiplegia		1
Type of accident	Successes	Failures
Automobile	12	3
Industrial	7	4
Fall	7	2
Athletic	4	
Blow	3	1
Birth injury		1
Unknown		1

\*These patients represent 66.66 per cent of successes listed

\*\*Only 2 patients, or 16.6 per cent of failures, had no organic symptoms at the time of operation

operation. Despite this obvious lack, however, my experience has satisfied me that this exploratory procedure is amply justified in any patient who is known to have sustained a craniocerebral injury, and who either asks to have it done or accepts it after having been told that it is quite as likely to be a useless as it is to be a useful procedure from his point of view.

### CONCLUSIONS

1 In patients who complain of symptoms which persist for a month or more after their discharge from medical care following an acute craniocerebral injury, it should be possible, provided the patient is hospitalized, to make (a) a probable diagnosis of head injury from the history, (b) an estimate of the efficiency of the earlier treatment and the probability of resultant late symptoms, and (c) a positive diagnosis of

previously unknown intercurrent disease and of residual objective signs of the previous injury.

2 The resultant diagnoses should be phrased as follows. "No present evidence of organic disease", "no present evidence of organic disease but a probable earlier craniocerebral injury"; or "present evidence of organic disease due to the residual effect of an old craniocerebral injury," or "to unconnected intercurrent disease"

3 These diagnoses should replace such meaningless and inaccurate terms as "posttraumatic and postconcussional neurosis" and should be made only after hospitalization of the patient

4 They do not rule out the presence of such conditions as a subdural hematoma, cortical atrophy or scars, or psychotic maladjustments as the cause of the symptomatology

5 Further investigative and diagnostic procedures include encephalography and transtemporal trephination

6 In a group of 47 patients who subjected themselves to diagnostic transtemporal trephination for symptoms that persisted for 1 month to

TABLE I

	Occurrence per cent
Non-operable cases	63.0
Concussion	9
Edema and congestion	18.2
Contusion	25.7
Laceration	17.3
Operable cases	36.9
Extradural hematomas	3.1
Depressed fractures	4.5
Compound fractures	11.3
Subdural hematomas	17.8

chronic forms of this condition. My experience leads me to this conclusion because in dealing with 330 hospitalized subdural hematoma suspects there were only 62 or a little under 2 per cent of the explorations that were negative. Patients who have subjective symptoms long after their injury and who also harbor subdural hematomas, have the fluid rather than the solid variety (5). Except as a guess it is impossible to diagnose this type of clot by any means other than exploratory trephination. This is well illustrated by the following characteristic case.

A twenty year old college student was knocked unconscious playing football while a freshman. During the following 2 years he was removed from college, sent back to school, had a diagnosis of and was bled for polycythemia was next considered to be a brain tumor suspect after which he moved to Chicago and was told he was hysterical. He then returned to New York where he had a negative encephalogram made and was sent to a well known sanatorium. It was decided at this latter place that he had neither hysteria nor a psychosis. Following this he was given pituitary extract as a possible pituitary tumor case had another encephalogram made in Chicago and then had his appendix removed. Despite all this he still had his headaches. He returned to college for 3 months but had to leave. I saw him at that time. He had no objective signs of central nervous system disease but was offered exploration and accepted. A fluid subdural hematoma was found and drained. His headaches and other symptoms were relieved by the time of his discharge from the hospital. He returned to college in 2 months and rejoined his original class. During the 4 succeeding years he graduated with honors, started in business and had no return of any symptoms whatsoever.

Since it is primarily diagnostic, the exploratory trephination need not be limited to subdural hematoma suspects. It may be legitimately used to verify other diagnoses such as cortical atrophy or scars or widespread arachnoidal adhesions. It will have a negative value also. This was well illustrated within my own experience by 2 instances.

In one a patient was suspected of having been the victim of an automobile accident but proved at exploration to have no appropriate cerebral pathology. Further investigation initiated as the result of this operation demon-

strated that he was suffering from acute bromidism and had never been in an accident. In the other case compensation was about to be paid for a hemiplegia alleged to have been induced while the patient was at work and as the result of an admitted injury that he had sustained 1 week previous to the onset of the paralysis. Exploration to verify the presence of a subdural clot demonstrated that he had had an arteriosclerotic thrombosis of one middle cerebral artery and that that was the cause of the hemiplegia which was entirely unconnected with the injury.

When a subdural hematoma is found by this means this same exploratory procedure can be used as a therapeutic measure. If the hematoma is, as usual, fluid it can be adequately drained and removed through only one transtemporal trephination. With this in mind the diagnostic operation should be started by trephining on the side opposite to the speech cortex. If this should prove negative the other side can be done.

Although invariably initiated as an exploratory diagnostic procedure, I have been able to make therapeutic use of this operation in 47 instances. All the patients had fluid subdural hematomas, all except 2 have been followed to date for periods varying from 1 month to 6 years (Table II) and all came under my observation for relief of symptoms that had persisted a month or more after they had been discharged from medical care administered for their original injury. Thirty three of these 45 cases were relieved of all symptoms and enabled to return to their normal life and occupations following the drainage of their hematomas. A study of Tables II and III will give the details of the successes and failures.

In general it can be said that in such patients (1) The type of occupation, kind of accident and length of the follow up after the first 2 postoperative years are of little significance in making the diagnosis or the prognosis. (2) The successful cases averaged 4 years younger than the failures. (3) The large majority of failures will be apparent after the first postoperative year. (4) The shorter the interval between the receipt of the blow and the removal of the hematoma, the better the result. In this series the number of failures was approximately 20 per cent greater than the successes at the end of the first postoperative year, 12 per cent at the end of the third and 19 per cent at the end of the sixth year. (5) Finally, and most important of all only 33 1/3 per cent of the successes as opposed to 83 per cent of the failures showed objective evidence of the presence of central nervous system disease previous to operation and in addition to the subjective symptoms.

Unfortunately no figures are available as to the number of patients studied on account of the same complaints but who refused exploratory

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Southside Hospital—E. R. Hildreth



18 years after craniocerebral injury, and who all had fluid cerebral subdural hematomas it was found that (a) the patients who were successfully treated in this way averaged 4 years younger than the failures, (b) the shorter the interval between the injury and the drainage of the hematoma, the greater was the chance for cure, (c) only 33½ per cent of the successful cases in contrast to 83 per cent of the failures showed objective evidence of central nervous system disease in addition to the subjective symptoms and (d) 73 per cent were permanently and completely relieved of objective and subjective symptomatology following removal of the fluid subdural hematoma.

## REFERENCES

- 1 COLEMAN C C Chronic subdural hematoma diagnosis and treatment. *Am J Surg* 1935 28 341
- 2 LEFEVER H E and SECREST R J The late effects of cerebral trauma—a study of 100 old head injuries. Unpublished work
- 3 MUNKRO D The diagnosis treatment and immediate prognosis of cerebral trauma. *New England J Med* 1934 210 287
- 4 Idem The diagnosis and treatment of subdural hematoma. Report of 62 cases. *New England J Med* 1934 210 1145
- 5 MUNKRO D and MERRITT H H The surgical pathology of subdural hematomas based on a study of 105 cases. *Arch Neurol & Psychiat* 1936 35 64
- 6 VON STORCH T J C and MUNKRO D Encephalography in the diagnosis of subdural hematomas. *New England J Med* 1938 218 6

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**L**EADING manufacturers of and dealers in surgical instruments, hospital apparatus and supplies, diagnostic and therapeutic apparatus, pharmaceuticals, and publishers of medical and surgical books were represented in the Technical Exhibition at the Waldorf-Astoria Hotel in New York, October 17-21, 1938

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# SURGERY

## GYNECOLOGY AND OBSTETRICS

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### MULTIPLE PRIMARY MALIGNANT LESIONS

LEONARD K STALKER, M.D., RICHARD B PHILLIPS, M.D., and  
JOHN deJ PEMBERTON, M.D., F.A.C.S., Rochester, Minnesota

**M**ULTIPLE primary malignant lesions occur more frequently than one would suspect before reviewing the literature of the past 20 years. We were stimulated in making such a review by the rather frequent occurrence of multiple primary malignant lesions in cases seen on the surgical service of one of us (Pemberton) in the year 1937. As a result, we reviewed all cases, approximately 2,500, in which operation was performed and a diagnosis of malignancy was made by a surgeon and pathologist at the Mayo Clinic in 1937.

The true significance of multiple primary malignant tumors has not yet been clearly established. It is hoped that studies of this kind, apart from their interest, may add to the genetic background of cancer. Billroth, in 1869, first reported cases of multiple malignant tumors. Rather comprehensive reviews have been made by Major (1918), Owen (1921), Hanlon (1931), Warren and Gates (1932), Hurt and Broders (1933), Schreiner and Wehr (1934), Bugher (1934), and Burke (1936).

Billroth, in 1869, proposed 3 postulates for the authenticity of multiple cancer: (1) Each tumor must have an independent histological appearance, (2) the tumors must arise in different situations, and (3) each tumor must

produce its own metastasis. Inasmuch as these conditions, especially the third one, are not usually fulfilled in cases in which operation is performed, we have used the criteria that have been proposed by Goetze, namely: The macroscopic and microscopic appearance of the tumors must be that of the usual carcinomas of the organs involved; exclusion of metastasis must be certain; diagnosis may be confirmed by the character of the metastasis in each case. Multiple primary neoplasms were found in 113, 4.52 per cent, of our series of approximately 2,500 cases of malignancy.

In 1931 Hanlon reviewed the reports of 3,000 consecutive necropsies performed at the Mayo Clinic. In 950 cases death was attributable to malignant tumors, in 710 of these cases the tumors were carcinomas. In 18, or 2.5 per cent, of the 710 cases of carcinoma multiple primary neoplasms were found.

Warren and Gates, in 1932, reported the results of necropsy in 1,078 cases of cancer, multiple primary neoplasms were found in 3.7 per cent of the cases. They also found reports of more than 1,200 cases of multiple primary malignant tumors in a review of the work of more than 430 authors. They said that on the basis of all statistics the incidence of multiple primary malignant tumors is 1.84 per cent in all cases of cancer, but that on the basis of the American figures alone the incidence is 3.9 per cent. They also expressed the

From the Division of Surgery, the Mayo Clinic and The Mayo Foundation

opinion that the occurrence of multiple malignant lesions is more frequent than can be explained on the basis of chance.

In 1933 Hurt and Broders reviewed a series of 2,124 cases of malignancy that were observed at The Mayo Clinic in 1929. The diagnosis was made by microscopic examination in all of the cases. Multiple primary malignant tumors were found in 71, or 3.3 per cent of the cases. The authors concluded that the factors which cause the development of the tumors also express themselves in the grade of malignancy, according to the classification of Broders. They expressed the opinion that the incidence of multiple primary malignant lesions was greater than would be expected if the occurrence was accidental.

Schreiner and Wehr, in 1934, reported a series of 11,212 cases of malignancy seen at the State Hospital, in Buffalo, New York, in 20 years. Multiple primary malignant lesions were found in 307, or 2.7 per cent of the cases.

Bugher, in 1934, reported the results of a series of 4,394 necropsies in 1933, or 22.3 per cent of the cases, deaths were due to cancer and in 30, or 3.1 per cent of the 983 cases there were multiple primary malignant tumors. He computed the expected occurrence of coincidental multiple primary malignant neoplasms from the mortality statistics in cases of cancer in the United States and found that it was exceeded by the actual occurrence.

Burke, in 1936, reported the results of a series of 2,033 necropsies performed at the Wisconsin General Hospital, at Madison. Cancer was found in 583, or 28.6 per cent of the cases. True multiple primary cancers were found in 46 or 7.8 per cent of the 583 cases.

The European figures for the most part have been derived from reports of a series of necropsies and, as a rule, indicate a lower incidence of multiple primary malignant tumors than do the American figures. Bilello and Montanini reviewed 8,024 cases in which necropsy was performed in Italy. Malignant tumors were found in 1,154 of the cases, but multiple primary malignant tumors were found in only 7 or 0.6 per cent, of the 1,154 cases. Gornaiowa and Schabad, of Leningrad, made a similar review of 6,652 cases in which necropsy was performed. They found 1,238 cases of malignancy, multiple malignant tumors were present in 23, or 1.8 per cent of the 1,238 cases.

There were 327 separate neoplasms in our series of 113 cases. In 51, or 45.1 per cent of the cases, multiple primary malignant lesions occurred simultaneously, in 62 or 54.9 per cent of the cases, the neoplasms appeared at different and varying intervals of time. In each case, however the patient was operated on and the diagnosis of malignancy was confirmed by microscopic examination in 1937. In 30 or 26.5 per cent of the cases an interval

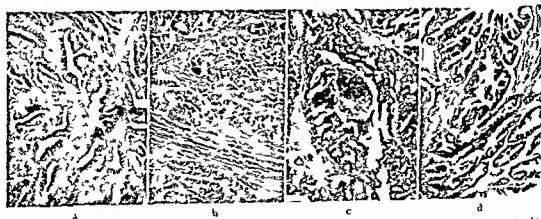


Fig. 1. Primary malignant lesions found in Case 1.  
a adenocarcinoma grade 1 of the descending colon  
( $\times 20$ ) b adenocarcinoma grade 1 of the uterus ( $\times 20$ )

c intracystic papillary adenocarcinoma grade 1 of the  
ovary ( $\times 35$ ) d papillary adenocarcinoma grade 1 of the  
left fallopian tube ( $\times 40$ )

of 5 years or more had elapsed between the development of individual lesions. In one case malignant tumors had occurred at varying intervals for 43 years. In the 30 cases the average interval had been 12.3 years, in 21 of the 30 cases, 10 or more years had elapsed between the development of individual neoplasms.

Sixty-three of the patients were females and 50 were males. The average age of the 113 patients was 59.7 years. Seventy-three of the patients were between 50 and 70 years of age.

In this series of 113 cases the distribution of the malignant lesions was similar to the usual distribution of such neoplasms. More than 2 primary malignant lesions were encountered in several of the cases. As many as 12 neoplasms of the skin were found in 1 case.

In 35 of the 113 cases the multiple primary malignant lesions involved only the skin. In the classification of the situation of the neoplasms those that involved the lips were included as lesions of the skin. Excluding the cases in which the neoplasms involved the skin, including the lips, there were 64 cases in which 2 or more primary malignant lesions were found. Two lesions were found in each of 50 cases, 3 lesions were found in each of 11 cases, 4 lesions were found in each of 2 cases, and 5 lesions were found in 1 case. In each of 14 other cases 1 or more primary malignant lesions of the skin were associated with a primary malignant lesion of some other organ.

Of the 327 lesions, 167 involved the skin and lip, 97 of these were basal cell epitheliomas, 69 were squamous cell epitheliomas, and 1 was a melano-epithelioma. The 167 skin neoplasms were distributed over the entire body but were chiefly confined to the skin of the face and neck. A skin lesion was found in 54 cases, in 35 of these cases the patients had multiple skin neoplasms only, with no evidence of other malignancy. In 19 cases the malignant lesion of the skin was associated with a malignant lesion in another part of the body. Twenty malignant lesions of the lip were found in a group of 18 cases, in 13 of these there also was some other malignant lesion of the skin. There were 43 neoplasms of the breast in a group of 28 cases.



Fig. 2. Gross specimen removed in Case 2, a large carcinoma, grade 2, is situated in the ascending colon and a similar lesion is situated in the transverse colon, numerous, small polyps are visible.

In this group 9 patients had bilateral mammary carcinomas without evidence of any other malignant lesion. Four patients had carcinoma of both breasts and 15 had carcinoma of one breast, all of these 15 patients also had a primary malignant lesion in some other part of the body. There were 27 malignant lesions of the ovary in a group of 17 cases. Primary malignant lesions of both

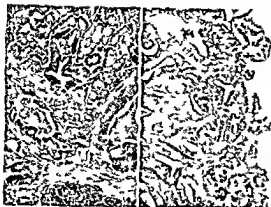


Fig 3 Malignant lesions found in Case 3 a at left adenocarcinoma grade 3 of the cecum (X27), b adenocarcinoma grade 3 of the sigmoid colon (X34)



Fig 4 Malignant lesions found in Case 5 a at left adenocarcinoma grade 3 of left breast (X54) b adenocarcinoma grade 4 of right breast (X74)

ovaries were encountered in 10 cases, in 2 of these cases there were primary malignant lesions in other parts of the body. In 7 cases a primary malignant lesion of the ovary was associated with a primary malignant lesion in another part of the body. There were 14 malignant lesions of the uterus and cervix in a group of 13 cases, 2 separate primary malignant lesions were found in 1 uterus. The neoplasm was primary in the cervix in 5 instances and in the fundus in 9.

Forty seven primary malignant lesions of the gastro intestinal tract were found in a group of 32 cases. Twenty four of the neoplasms were situated in the colon, 13 were in the rectum, 8 were in the stomach, 1 was in the esophagus, and 1 was in the anus.

A miscellaneous group included a variety of primary malignant growths. The tongue was involved in 4 cases, the urinary bladder and prostate gland each were involved in 3 cases, the paranasal sinuses, pharynx, larynx, parotid gland, and thyroid gland each were involved in 2 cases and the brain, bronchus, kidney, mastoid cells and fallopian tube each were involved in 1 case. In this group must also be included 4 sarcomas that were situated in various parts of the body.

#### REPORT OF CASES

Ten of the cases are of special interest. In the reports of these cases the stated ages of the patients are the ages at the time the patients were observed at the clinic in 1937. Five pri-

mary malignant lesions were found in Case 1. There also was a family history of cancer in this case.

**CASE 1.** The patient was a woman aged 69 years. Her father, mother and 3 cousins had died of cancer. In 1921 operation elsewhere had disclosed a definite carcinoma of the ascending colon. Two other operations were performed at the clinic. The first of these operations at the clinic was performed because of carcinoma of the descending colon. The second operation disclosed separate neoplasms of the uterus, right ovary and left fallopian tube (Fig 1). The pathologist reported that these neoplasms found in the descending colon, uterus, right ovary and left fallopian tube were primary malignant lesions.

**CASE 2.** The patient was a woman aged 58 years. Her mother had died at the age of 33 years of an abdominal tumor that probably was malignant. A total abdominal hysterectomy had been performed in 1931 for adenocarcinoma of the uterus. In 1931, a resection of the ascending colon and the right half of the transverse colon was performed for a carcinoma of the cecum and another carcinoma of the transverse colon (Fig 2). There were several small polyps in the segment of the colon that were removed.

The following case has been reported previously by Dr C H Smith. In this case the family history of the same type of carcinoma was rather pronounced.

**CASE 3.** The patient was a man aged 47 years. His father had died of carcinoma of the stomach and his brother had been a patient at the clinic in 1933 when he had undergone a resection of the colon for adenocarcinoma grade 4. An exploratory laparotomy which was performed September 4, 1935 disclosed a carcinoma of the sigmoid colon.

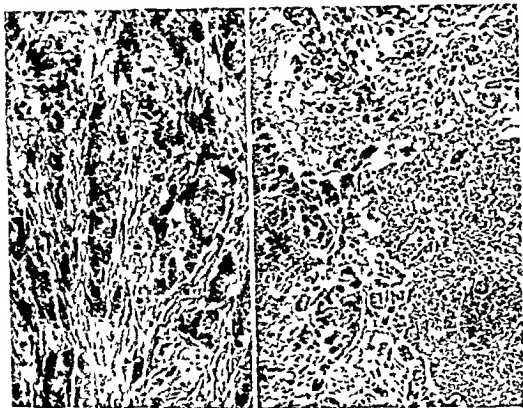


Fig 5 Malignant lesions found in Case 6, a, at left, adenocarcinoma, grade 3, of breast ( $\times 77$ ), b, adenocarcinoma, grade 4, of lymph node of stomach ( $\times 100$ )

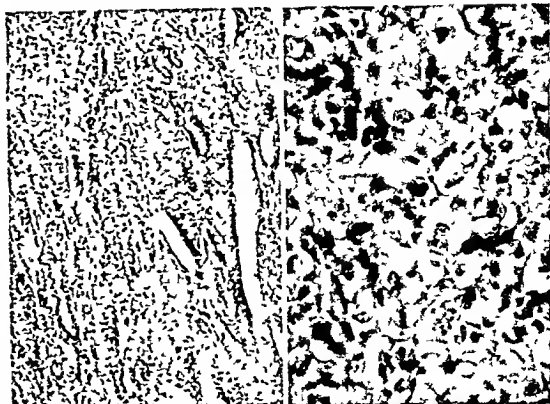


Fig 6 Malignant lesions, Case 9, a, at left, adenocarcinoma, grade 3, of left breast ( $\times 51$ ), b, endothelial sarcoma of lymph node obtained from right axilla ( $\times 255$ )

and a large carcinoma of the cecum. The cecum and a portion of the large and small intestine were resected. The neoplasm in the cecum was an adenocarcinoma, grade 3 (Fig 3a). On September 25, 1935, the sigmoid colon was resected, the lesion in this segment of the intestine was a carcinoma, grade 3 (Fig 3b). The patient returned to the clinic on November 8, 1937, examination at that time disclosed a carcinoma of the descending colon, which proved to be an adenocarcinoma, grade 3.

It is of interest to note that the brother of the patient in Case 3 returned to the clinic in February, 1938. Examination disclosed a carcinoma of the rectum, grade 2.

**CASE 4** The patient was a woman, aged 36 years. A radical amputation of the left breast had been performed in 1935, because of carcinoma. In December, 1935, a resection of the descending colon was performed at the clinic, because of adenocarcinoma, grade 2. A radical amputation of the right breast was performed in 1937, because of adenocarcinoma, grade 3.

In the following case an interval of 15 years elapsed between the development of malignant lesions of the breasts.

**CASE 5** The patient was a woman, aged 63 years. Her mother had died of carcinoma of the liver and her father had died of carcinoma of the stomach. Her first visit to the clinic was in 1922, when an operation was performed for adenocarcinoma, grade 3, of the left breast (Fig 4a). She returned to the clinic in 1937 and underwent an operation for adenocarcinoma, grade 4, of the right breast (Fig 4b). In the course of this operation 4 rather discrete basal cell epitheliomas were removed from the skin of the trunk.

**CASE 6** The patient was a woman, aged 67 years. She first came to the clinic in 1921. At that time a radical mastectomy was performed because of adenocarcinoma, grade 3 (Fig 5a). In 1936 a resection of a portion of the descending colon was performed elsewhere because of adenocarcinoma, grade 2. The patient returned to the clinic in 1937. At this time she was subjected to operation because of adenocarcinoma, grade 4, of the stomach (Fig 5b).

In Case 6 there was no family history of cancer but the patient had had 2 malignant lesions before the one that was found when she returned to the clinic in 1937. Fifteen years had elapsed between the occurrence of the first 2 malignant lesions.

The next case, which demonstrates the occurrence of identical malignant lesions of bilateral organs of homologous twins, has been reported previously by Phillips and Broders.

**CASE 7** The patient was a woman, aged 48 years, she was an identical twin. Her paternal aunt had died of carcinoma of the breast, at the age of 45 years. In 1927 an older sister had undergone an operation for a tumor of the breast. A radical mastectomy had been performed in 1927 because of adenocarcinoma, grade 4, of the right breast. Another radical mastectomy had been performed in 1928 because of a similar neoplasm of the left breast. She first came to the clinic in 1937. At this time she was subjected to operation for papillary adenocarcinoma, grade 3, of both ovaries.

In 1930 her twin sister had undergone a simple mastectomy for early carcinoma, grade 4, of the right breast. This twin came to the clinic in 1932, because of a recurrence of the neoplasm on the right side. Examination also disclosed a growth in the





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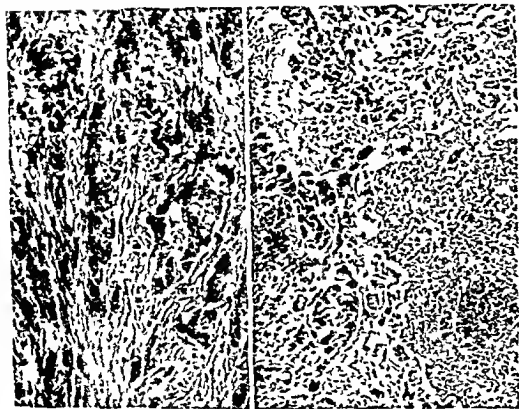


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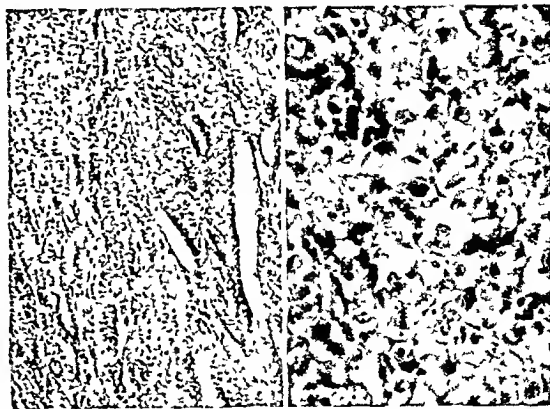


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Fig 7 Malignant lesions found in Case 10: a, at left adenocarcinoma grade 4 of breast ( $\times 40$ ), b, adenocarcinoma grade 1 of uterus ( $\times 43$ )

left breast. Operation disclosed that the lesion of the left breast was an adenocarcinoma grade 4. A radical dissection was performed on the right side; this revealed that the recurrent neoplasm also was an adenocarcinoma grade 4. At the time this was written there was no evidence of a malignant lesion of either ovary of the second twin.

In the following case an unusual combination of neoplasms was encountered.

**CASE 8.** The patient was a woman aged 51 years. Her uncle had died of carcinoma of the lip. In 1933 a radical mastectomy had been performed for carcinoma of the left breast. The patient came to the clinic in 1937. At this time a total hysterectomy was performed because of sarcoma of the left ovary. In examining the specimen that was removed at the operation the pathologist encountered an endometrial polyp that contained 2 separate malignant lesions: a sarcoma and a carcinoma.

In the following case carcinoma and sarcoma occurred simultaneously.

**CASE 9.** The patient was a woman aged 55 years. In March 1937 a radical mastectomy was performed because of an adenocarcinoma grade 3 of the left breast (Fig 6a). Two months later a mass of lymph nodes was removed from the right axilla. Examination of this mass disclosed a sarcoma of the endothelial type (Fig 6b).

**CASE 10.** The patient was a woman aged 53 years. One brother had died of carcinoma of the stomach and another brother had died of carcinoma of the colon. The patient came to the clinic in 1934 at that time her breast was removed because of adenocarcinoma grade 4 (Fig 7a). In 1937 a hysterectomy was performed because of adenocarcinoma grade 1 of the uterus (Fig 7b).

#### REMARKS

In this series of cases the skin, including the lip, was involved more frequently than was the rest of the body. In the cases in which the skin was involved the incidence of basal cell epithelioma was slightly greater than that of squamous cell epithelioma. A history of a previous dermatitis such as psoriasis or which had followed some kind of chemical irritation, or roentgen therapy was obtained in many cases of neoplasms of the skin.

In 17 cases the only malignant lesions encountered were neoplasms of each of bilateral organs, namely, the breasts and ovaries. Many authors may criticize us for including these neoplasms as multiple primary malignant lesions because the possibility of metastasis from the opposite breast or ovary is considered by some to be strong. It is true that an absolute proof of the true primary nature of a growth such as one of this type is difficult to obtain, but in many instances there was a difference in the grading of the lesion, a difference of many years between the occurrence of the 2 neoplasms, and in some instances there was a difference even in the type of lesion. We believe that neoplasms in each of bilateral organs are more often primary, so have included all bilateral malignant lesions as being primary and feel that their situation relative to one another is immaterial.

The average age of the 113 patients in the year 1937 was 59.7 years. If this figure had been determined on the basis of the age at the time of the occurrence of the first primary malignant lesion the figure would have been somewhat lessened. It would then be less than the average age reported by many other authors, such as 62.6 years reported by Hanlon, 62.1 years reported by Owens, 50.4 years reported by Hurt and Broders and 55.5 years reported by Warren and Gates. We feel that these ages would represent the average age for the occurrence of single malignant lesions and do not believe that the prevalent impression that multiple malignant lesions occur more often at an advanced age than do single malignant lesions is based on adequate data.

The number of females in comparison to the number of males is slightly increased, but

this increase is not great enough to be of any significance. This has been the usual observation of other authors.

The fact that more than a fourth of our patients had an interval of more than 5 years between the noted occurrence of the first and second lesions is of interest, but we feel that it is of only slight significance. Of course, the longer the interval between the development of the 2 primary malignant lesions, the more certain is the likelihood that the second neoplasm is not a metastasis or recurrence of the first. In the majority of our cases the multiple malignant lesions developed simultaneously. This would suggest that more than one primary focus for the development of cancer may have been present in each of these cases.

A family history of malignancy was noted in 26.6 per cent of the 113 cases. This agrees with the 15 to 30 per cent reported by other authors. It seems that a percentage such as this would in part substantiate the definite views of many authors that there is a hereditary factor in the etiology of cancer. In many of the cases (Cases 1, 2, 3, 5, 7, 8, and 10) several members of the family had had cancer. In one case, Case 6, which previously was reported by Phillips and Broders, simultaneous bilateral carcinomas of the breast occurred in each of homologous twins. McFarland and Meade have collected 20 reports of cases in which identical tumors have occurred simultaneously in the same organs of identical twins. Since homologous twins originate from the same fertilized ovum, it follows that they have identical genetic constitutions. It may be that the study of cases such as these, from the standpoint of genetics, will help to throw some light on the solution of the genesis of cancer. The genetic factors in the development of cancer in human beings eventually will be given greater consideration. The occurrence of cancer among several members of one family should be discussed rather frankly with other members of the family, the discussion should include the known hereditary aspects of cancer. In this way the development of cancer among other members of the family might be prevented or arrested at an early stage. They would be encouraged to co-operate with the physician and undergo

periodic health examinations. They might be prompted to seek early advice regarding painless lumps, or about other signs which ordinarily, to them, might seem insignificant. This procedure might avoid or eliminate sources of irritation, and in some few cases it possibly might restrict reproduction.

Holman and Lockhart-Mummery recently have expressed similar opinions. It is difficult to speculate as to why an individual with one cancer should have another separate and apparently unrelated neoplasm at a later date. Some authors, as for example Bugher, have demonstrated that the incidence of the development of multiple primary neoplasms is greater than one would expect on the basis of chance alone. This implies the presence of a definite predisposition or susceptibility to malignancy, or to the action of some factor favoring the development of malignancy in cases such as we have reported.

#### SUMMARY

A review was made of 2,500 cases of malignant lesions in which operation was performed at the clinic during the year 1937. One hundred thirteen instances of multiple primary neoplasms were found in this group of cases.

Three hundred twenty-seven separate neoplasms were observed in the 113 cases; 167 involved the skin and lip, 47 of the neoplasms were situated in the gastro-intestinal tract, 43 in the mammary gland, 27 in the ovaries, 14 in the uterus or cervix, and 29 were situated in various regions and, therefore, are classified as miscellaneous.

#### REFERENCES

1. BILELLO, A., and MONTANINI, N. Quoted by Burke, Mead. Loc cit, 4.
2. BILLROTH, C. A. T. Quoted by Warren, Shields and Gates. Loc cit, 17.
3. BUGHER, J. C. The probability of the chance occurrence of multiple malignant neoplasms. *Am J Cancer*, 1934, 21: 809-824.
4. BURKE, MEAD. Multiple primary cancers. *Am J Cancer*, 1936, 27: 316-325.
5. GOETZF, OTTO. Bemerkungen ueber Multiplizitaet primaerer Carcinome in Anlehnung an einen Fall von dreifachem Carcinom. *Ztschr f Krebsforsch*, 1913, 13: 281-302.
6. GORIAINOWA, R. W., and SCHABAD, L. M. Zur Frage der multiplen primaeren Geschwuelste. *Ztschr f Krebsforsch*, 1931, 33: 594-599.
7. HANLON, F. R. Multiple primary carcinomas. *Am J Cancer*, 1931, (Suppl) 15: 2001-2012.

- 8 HOLMAN EMILF Concerning the hereditary nature of cancer Surg Gynec & Obst 1938 66 247-249
- 9 HURT H H, and BRODERS A C Multiple primary malignant neoplasms J Lab & Clin Med 1933 18 765-777
- 10 LOCKHART WILMERY J P The surgeon as a biologist Surg Gynec & Obst 1938 66 57-263
- 11 MAJOR R H Multiple primary malignant tumors, with report of a case of carcinoma and sarcoma in the same individual Bull Johns Hopkins Hosp 1918 29 223-231
- 12 MCFARLAND JOSEPH and MEADE T D The genetic origin of tumors supported by their simultaneous and symmetrical occurrence in homologous twins Am J M Sc 1932 184 66-80
- 13 OWEN L J Multiple malignant neoplasms. J Am. M Ass 1921 76 1329-1333
- 14 PHILLIPS R B, and BRODERS A C Identical cancers in identical twins Proc Staff Meet Mayo Clin 1948 13 209-216
- 15 SCHREINER B F and WEHR W H Multiple primary cancer as observed at the State Institute for the study of malignant disease Am J Cancer 1934 20 418-424
- 16 SMITH C H Surgical removal of three primary malignant carcinomas of the colon in a single case Proc Staff Meet Mayo Clin 1938 13 117-123
- 17 WARREN SHIELDS and GATES OLIVE Multiple primary malignant tumors Am J Cancer 1932 16 1358-1414

# THE FATE OF LIVING AND DEAD CARTILAGE TRANSPLANTED IN HUMANS

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**S**URGICAL opinion differs widely concerning the fate of various types of cartilage grafts after transplantation in human tissues. Numerous investigators have buried cartilage grafts in animals, and our knowledge of the behavior of human cartilage grafts is based very largely on the conflicting results of this animal experimentation.

Desiring to obtain more definite information concerning the fate of human cartilage grafts in human tissues, I performed the following experiments.

1 Six segments of cadaver cartilage preserved in alcohol were transplanted beneath the skin of 6 other humans (homografts) and removed for examination at intervals from 6 months to 2 years.

2 Eight segments of living autogenous costal cartilage were buried beneath the skin of 8 humans and removed for examination at intervals from 6 months to 6 years. All of these grafts were transplanted without perichondrium.

*Cadaver cartilage grafts* The use of cartilage preserved in alcohol to fill depressions of the nose, face, and skull, like most surgical procedures, is not new. It was utilized rather extensively a generation ago and was discarded because of the belief that the grafts either suppurated or were absorbed and replaced by fibrous tissue. Recently there has been a revival of the method. Pierce and O'Connor, J. B. Brown, Claire Straith, C. R. Straatsma, and I, among others have used cartilage preserved in alcohol to repair saddle nose and defects of the skull. Successful grafts examined by external palpation appear to retain their size and consistency to periods of over a year.

The advantage of this procedure is obvious, as fresh cartilage from cadavers is easily obtainable in almost any desired quantity, and

a supply of this cartilage preserved in alcohol may be kept on hand in the hospital laboratory for use when needed. It goes without saying that the donor must be proved free from syphilis. The disadvantage of the method lies in the uncertainty as to the ultimate fate of the transplant.

*Autogenous rib cartilage grafts* Koenig, in 1896, was the first to use cartilage transplants in man, and since that time, living autogenous rib cartilage has been employed widely as a filling substance, and for the structural support of soft tissues.

There is, however, a great difference of opinion concerning the fate of the autogenous cartilage graft following transplantation. In the literature one finds a variety of conflicting reports all based on clinical observation of the grafted area. A single exception is the report of Gillies on one specimen of rib cartilage examined microscopically 18 months after transplantation. A questionnaire sent to 10 surgeons, who frequently use rib cartilage grafts, disclosed a variety of beliefs concerning the fate of the grafts. These opinions were based on clinical evidence and may be summarized as follows: (1) Cartilage tends to survive when transplanted. (2) Cartilage tends to degenerate when transplanted. (3) Cartilage survives when transplanted with its perichondrium, but tends to degenerate and disappear when transplanted without its perichondrium.

## PREVIOUS EXPERIMENTAL WORK WITH LIVING CARTILAGE IN ANIMALS

The literature on cartilage during the past 80 years is so extensive that I have attempted to summarize only the most important work and indicate its significance.

Paul Bert was probably the first to transplant cartilage. From his experimental studies with animals he came to the conclusion that a cartilage graft retained its viability and led to

Read before the Society of Plastic and Reconstructive Surgery, St. Louis, Missouri, October 22, 1937.

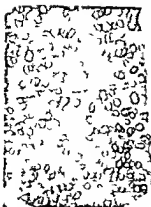


Fig 1



Fig 2



Fig 3

Fig 1 Alcohol preserved septal cartilage buried 6 months. The cartilage cells are greatly shrunken but there is no invasion or absorption of the cartilage graft.

Fig 2 Alcohol preserved rib cartilage buried 9 1/2 months. This section shows the earliest invasion of the dead cartilage grafts in my series. The cartilage is represented at A and the dense host connective tissue capsule surrounding the cartilage at B. At C one edge of the cartilage is invaded by ingrowing fibroblasts from the capsule and there is partial absorption in this area.

Fig 3 Alcohol preserved septal cartilage buried 14 months. The cartilage is divided into a separate portions by invading host fibrous tissue. There are numerous blood vessels and giant cells in the invading fibrous tissue and the edges of the cartilage show indentations where absorption has taken place. A and B represent the cartilage and C the invading fibrous tissue.

the formation of bone. He experimented probably before 1865, but this is our first reference.

Ollier, in 1867, and Zahn in 1884, assumed a diametrically opposed view of the fate of adult animal cartilage transplants. They both noted degenerative changes in the grafts that led ultimately to their absorption. Zahn concluded that cartilage grafts degenerated whether transplanted into the same animal (autografts) or transplanted into different animals (homografts and heterografts).

Fischer is responsible for the origin of the theory that the survival of a cartilage graft is dependent on the presence of the perichondrium. In his experiments, costal cartilage degenerated after about 8 weeks when transplanted as a homograft without its perichondrium. Cartilage transplanted with its perichondrium showed little alteration in structure over the same period of time.

We find expressed in this early experimental work on animals the 3 viewpoints as to the fate of adult cartilage transplants which still exist today. (1) Cartilage tends to survive when transplanted. (2) Cartilage tends to degenerate when transplanted. (3) Cartilage survives when transplanted with

its perichondrium but tends to degenerate and disappear when transplanted without its perichondrium.

Illustrating the more recent work on cartilage transplants in animals, Leo Loeb in 1920 buried xiphoid cartilage with perichondrium and the fat of guinea pigs in the same guinea pig (autograft) and in different guinea pigs (homograft). He removed the cartilage at intervals of 1 day to 5 months and 19 days. He found that after autotransplantation reaction in the tissues about the transplant was almost entirely lacking.

After homotransplantation lymphocytes collected about the graft and, in places, lymphocytes connective tissue cells, and blood vessels entered necrotic portions of the cartilage. The reaction to the graft began early, reached a maximum in about 3 weeks, and from that time on ceased to a great extent. Both the autograft and the homograft remained up to 5 months and 10 days.

Mannheim and Zyplm performed 50 experiments with guinea pigs transplanting cartilage from one part of the animal to another in the same animal. Their conclusions on sections examined up to one year after



Fig 4

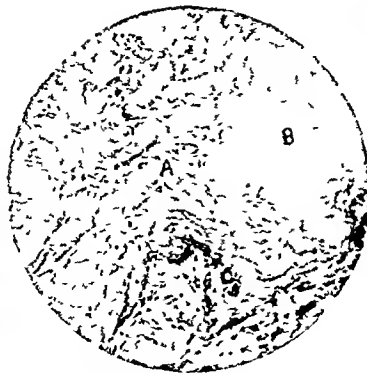


Fig 5



Fig 6

Fig 4 Alcohol preserved rib cartilage buried 18 months. Thin strands of host fibrous tissue are shown invading the cartilage between the letters *A* and *B*. There is a large area indicated by *C* where absorption of cartilage has taken place. This space is occupied by host fibrous tissue containing many blood vessels, giant cells, and endothelial cells.

Fig 5 Alcohol preserved septal cartilage buried 18 months. The cartilage graft is broken up into many small

cartilaginous islands by invading host fibrous tissue. One of these small cartilage islands is indicated by *A* and a larger mass of cartilage by *B*. The host connective tissue just outside of the cartilage graft contains numerous giant cells indicated at *C*.

Fig 6 Alcohol preserved septal cartilage buried 2 years. The cartilage graft is invaded by numerous fibrous tissue ingrowths. Two of these areas are indicated by *A* and *B*. A portion of the cartilage has been changed to bone at *C*.

transplantation were (1) The cartilage retained its specific structure in all cases (2) Both degenerative and regenerative processes occurred (3) The cartilage, after transplantation in soft parts, was better preserved than after transplantation in the skull (4) Cartilage transplanted without its perichondrium was better preserved than cartilage transplanted with its perichondrium (5) Free autotransplanted cartilage grafts form a good material for plastic repair.

#### PREVIOUS EXPERIMENTAL WORK WITH LIVING CARTILAGE IN HUMANS

Koernig, in 1896, was the first to use cartilage transplants in humans. He buried cartilage segments as wedges for the repair of partial destruction of the laryngeal and tracheal cartilages.

Von Mangoldt, in 1899, successfully transplanted costal cartilage for support of the nose.

Nelaton and Ombredanne, in 1904, buried costal cartilage in forehead flaps which were later swung down to the nose.

Neuhof, in 1923, after an extensive survey of the literature concluded that simple cartilage grafts, after transplantation, remain unaltered in appearance and in staining reaction

for many weeks, only in grafts that are several months old does fibrillation of the cartilage begin. There is a gradual death of the cartilage cells and they disappear ultimately. Vascularization of the graft, and replacement by fibrous tissue or calcification, may occur, depending on the locality in which the graft is transplanted. The outstanding feature in the histological fate of cartilage transplants is the long period of quiescence that precedes the final phase of the degeneration and substitution. In referring to rib cartilage transplants, Neuhof states: "The cartilage is absorbed slowly, allowing adequate time for replacement by dense fibrous tissue that maintains the architecture of the graft." He further says that remnants of cartilage have been found as long as 2 years after transplantation.

In opposition to this viewpoint, the earlier work of Staige Davis, in 1917, gave clinical evidence of the permanence of the rib cartilage transplanted in the nose.

Gillies also, in 1920, stated that no changes other than curvature were found in any of his successful autcartilage grafts, and in only a few of the homografts was the cartilage replaced by fibrous tissue as a late sequel. Three years was the longest that Gillies had a graft under observation. Gillies buried an auto-



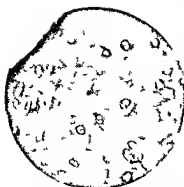


Fig 7



Fig 8

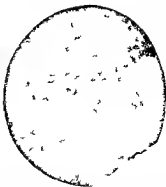


Fig 9

Fig 7 Autogenous rib cartilage graft buried 6 months. The cartilage appears normal and is not invaded or absorbed.

Fig 8 Autogenous rib cartilage graft buried 9 months. The cartilage which has taken a deep stain is indicated by

A and the host connective tissue by B. There is no evidence of invasion or absorption.

Fig 9 Autogenous rib cartilage graft buried 11 months. The section was photographed under low power magnification and shows no evidence of invasion or absorption.

cartilage graft and a fresh homocartilage graft beneath the abdominal skin of the same patient. He removed both grafts after 18 months, and on section, found the cartilage alive and active in both cases. The cells in the homograft were more vacuolated and showed more degenerative changes than did those of the autograft. The autograft appeared as normal adult cartilage.

Other important contributions were given by Henle, Lexer, Eiselsberg, Sgambati, Schmieden, Tuffier, Morestin, Gosset, Lenche, Quern, and Bossi.

#### PREVIOUS EXPERIMENTAL WORK WITH THE TRANSPLANTATION OF DEAD CARTILAGE IN ANIMALS

Even in the literature of over 50 years ago there are instances of the homotransplantation of fixed or dead cartilage with the use of alcohol, heat, and other agencies as the fixing or killing agent.

Prudden in 1881, transplanted cartilage grafts killed by immersion in 95 per cent alcohol. His results showed degeneration and partial absorption of all these grafts.

Nageotte in 1922, buried rabbit cartilage fixed in alcohol, in rabbits' ears. He found that the fixed cartilage lost its basophilic staining and promoted a metaplasia of the fibroblasts which surrounded it into chondroblasts with the consequent new formation of

cartilage and bone. Phagocytes and fibroblasts penetrated only into the open cavities at the periphery of the graft and in the cracks which eventually gave access to the surrounding host tissue cells.

Poletini, in 1922, pursued similar experiments with cartilage fixed in alcohol. His sections showed penetration of fibroblasts and formation of connective tissue fibers within the cartilage where no cavities or cracks previously existed as a point of entry. He also found cartilage and bone formation in the vicinity of the graft.

Nigrisoli in 1927 transplanted calves cartilage fixed in 95 per cent alcohol into the kidney and bone of guinea pigs. He removed his grafts from 6 days to 180 days, and found that the bulk of the graft survived in each case. Connective tissue from the host tended to invade the cartilage and calcifications were found in the grafts. Very rarely did he find re-formed bone and cartilage outside of the graft.

Didier and Guyon, in 1928, transplanted killed cartilage grafts in the ear, shoulder and linea alba of rabbits. They observed grafts up to 8½ months, and found calcification and invasion by fibroblasts from the host tissue. One case showed ecchondroses and another case showed ossification with the formation of fatty marrow. Two cases showed a clear histological picture of bone formation.

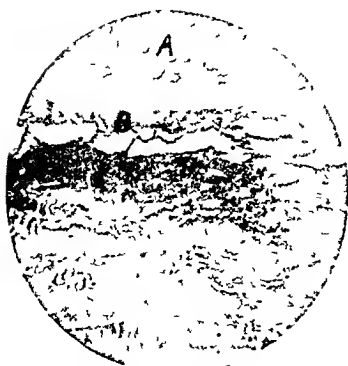


Fig 10

Fig 10 Autogenous rib cartilage graft buried 18 months. The cartilage is indicated at A and the host connective tissue at B. There is no invasion or absorption of the cartilage.

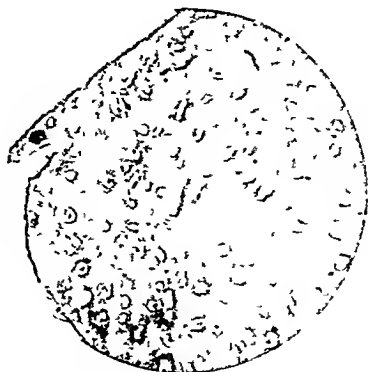


Fig 11

Fig 11 Autogenous rib cartilage graft buried 2 years. The matrix and cells appear normal and there is no evidence of invasion or absorption.

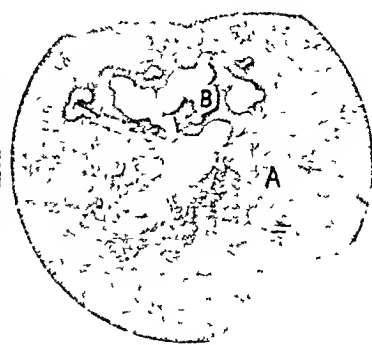


Fig 12

Fig 12 Autogenous rib cartilage graft buried 4½ years. The section shows a cortex of normal appearing cartilage with a cavity in the center which is partially occupied by strands of bone. I believe that the center of this cartilage graft failed to survive transplantation because of nutritional difficulties and was transformed to bone (see text). A represents the cartilage and B the strands of bone.

The newer literature, while reporting the survival of killed cartilage transplants, emphasizes the reaction of the host tissue and a very gradual modification of the cartilage. The modification included calcification and ossification as progressive changes, and invasion by fibroblasts with degeneration of the matrix as degenerative changes. These changes do not interfere with the survival of the block of cartilage up to periods as long as 1 year.

The work here summarized, with fixed or dead cartilage transplants, was all performed in animals. The following is an account of transplants made in humans.

#### PREVIOUS EXPERIMENTAL WORK WITH THE TRANSPLANTATION OF DEAD CARTILAGE IN HUMANS

The author (14) buried segments of cadaver septal and rib cartilage preserved in alcohol beneath the chest skin of humans and removed them at intervals of 7 days, 8 days, 32 days, 4 months, and 14 months. All of the grafts up to and including the 4 month specimen remained as tolerated dead foreign bodies. The 14 month section showed invasion by fibrous tissue, partial absorption of the cartilage and in one area calcification or early bone formation. The perichondrium was removed from these grafts before transplantation.

*Experimental procedure* All this work was performed on human beings. The experimental subjects, as in previous work with dermal grafts (15) were patients who underwent rib graft operations for the repair of saddle nose or skull depressions. In these operations it is customary to hoard excess rib cartilage beneath the chest skin to be used in case the cartilage inserted in the nose or scalp fails to remain in place. When the plastic repair is satisfactory, the excess cartilage beneath the chest skin is removed and discarded. Segments of human costal and septal cartilage preserved in 50 per cent alcohol for one month or more were inserted beneath the chest skin as dead homografts, together with the hoarded rib cartilage and removed for examination at intervals of 6, 9½, 14, 18, and 24 months (Figs 1-6).

The living autogenous rib cartilage grafts were obtained in a like manner with the exception of the 4½ year and 6 year specimens which were removed from the nose. Eight specimens of autogenous rib cartilage grafts are shown removed at intervals of 6, 9, 11, 17, and 18 months, 2, 4½, and 6 years. The perichondrium was removed from all of the cartilage grafts before transplantation (Figs 7-14). The specimens<sup>1</sup> were fixed in Zenkers

<sup>1</sup>The sections were prepared and photographed by Mr. David J. McKinnon, of the Newark Eye and Ear Infirmary. Dr. Royce Paddock aided in reviewing the foreign literature.

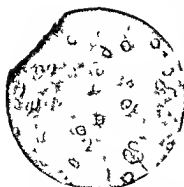


Fig 7

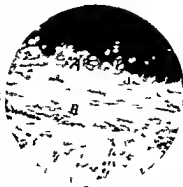


Fig 8

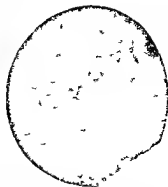


Fig 9

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Fig 8 Autogenous rib cartilage graft buried 9 months. The cartilage which has taken a deep stain is indicated by

4 and the host connective tissue by B. There is no evidence of invasion or absorption.

Fig 9 Autogenous rib cartilage graft buried 11 months. The section was photographed under low power magnification and shows no evidence of invasion or absorption.

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The specimen, buried  $4\frac{1}{2}$  years (Fig 12), shows a large segment of normal appearing cartilage with a free space in its central portion. A part of this central space is occupied by bone which extends lengthwise through the center of the graft, and at one point communicates with the surface at the side of the graft. I believe that this condition occurred the following way; after transplantation of a large block of cartilage, the peripheral portions of the cartilage are able to obtain better nourishment from the surrounding tissues than the more remote central portion. The central portion, therefore, becomes devitalized, or actually dies from lack of nutrition, and is transformed into bone. The bulk and shape of the cartilage graft is not changed, and the peripheral portion of the graft, which obtains adequate nourishment, remains as living cartilage. The bone formation, therefore, represents a degeneration at the core of the graft, where the cartilage failed to survive because of nutritional insufficiency. The specimen of cartilage buried 6 years (Fig 14) appears as normal living cartilage with no evidence of fibrous tissue invasion or absorption. The surrounding connective tissue is in close contact with the cartilage and on one side gives the appearance of slightly penetrating the external surface of the cartilage. This cartilage graft, however, was scraped with a scalpel before insertion in the nose, and I believe that the surrounding host tissue merely occupies the small depressions formed in the cartilage by the scraping of its external surface. The failure of the host connective tissue to penetrate more deeply at these favorable entry points is further evidence of the surviving power of autotransplanted rib cartilage.

#### SUMMARY OF FINDINGS IN AUTOGENOUS RIB CARTILAGE GRAFTS

The cartilage grafts buried from 6 months to 2 years, showed no evidence of invasion by fibrous tissue or absorption.

The graft, buried  $4\frac{1}{2}$  years, appeared in the form of a cylinder of living cartilage, with bone formation in the center. I believe that this bone formation at the core of the graft represents a degeneration of cartilage which

failed to survive transplantation because of nutritional difficulties.

The segment buried 6 years appeared as normal living cartilage. The host connective tissue on one side of the graft slightly penetrated the edge of the cartilage and this may represent beginning invasion. The cartilage graft, however, was scraped with a scalpel before insertion in the nose, and I believe that the surrounding host tissue merely occupies the small depressions formed in the cartilage by the scraping.

#### CONCLUSIONS

1. The dead cartilage grafts buried from  $9\frac{1}{2}$  months to 2 years showed progressive invasion by fibrous tissue and partial absorption. In contrast to these findings autogenous rib cartilage grafts showed no invasion or absorption over the same period of time.
2. Two late autogenous rib cartilage grafts buried  $4\frac{1}{2}$  years and 6 years appeared as living cartilage.
3. From the evidence found in these sections one may conclude that autogenous rib cartilage survives after transplantation as living cartilage and, up to periods as long as 6 years, neither increases nor decreases in size.
4. Autogenous rib cartilage is better material for plastic repair than dead, pickled cartilage.

#### BIBLIOGRAPHY

1. BERT, P. Sur la greffe animal. *Compt rend Acad d sc, Par*, 1865, 61, 587.
2. DAVIS, J. S. Some of the problems of plastic surgery. *Ann Surg*, 1917, 66, 88.
3. DIDIER, R., and GUYON, L. Production de cartilage et d'os, au sein de greffes vivantes et mortes, chez le lapin. *Compt rend Soc de biol*, 1928, 98, 443.
4. FISCHER, E. Ueber Transplantationen von organischem Material. *Deutsche Ztschr f Chir*, 1882, 17, 362.
5. GILLIES, H. O. *Plastic Surgery of the Face*. Pp 13-14. London: Oxford University Press, 1920.
6. KOENIG, F. *Berl klin Wchuschr*, 1896, 51, 1129.
7. LOEB, L. Autotransplantation and homio-transplantation of cartilage in guinea-pig. *Am J Path*, 1926, 2, 111.
8. MANNHEIM, A., and ZIPLIN, B. Free autoplasic cartilage transplantation. *Arch f klin Chir*, 1926, 141, 688, abstr in *J Am M Ass*, 1926, 87, 2132.
9. NAGEOTTE, J. *The Organization of Material in Its Relation to Life*. Paris: Masson & Cie, 1922.
10. NELATON, C., and OMBREDANNE, L. *La rhinoplastie*. Paris: G. Steinheil, 1904.



Fig. 13. At left Autogenous rib cartilage graft buried 4 1/2 years. A higher magnification photograph of the 4 1/2 year section shows the bone at A and the cartilage at B. Note the abrupt change from bone to cartilage.

Fig. 14. Autogenous rib cartilage graft buried 6 years. The cartilage cells and matrix appear normal. There is

however, a slight penetration of fibrous tissue into the edge of the cartilage. This cartilage graft was scraped with a scalpel before insertion in the nose and I believe that the fibrous tissue merely occupies the small depressions in the cartilage resulting from this scraping. Surrounding connective tissue is in close contact with cartilage.

solution, sectioned in the usual manner, and stained with hematoxylin and eosin and with Mallory's connective tissue stain.

Presentation of the living and dead cartilage grafts together is advantageous, since the dead grafts which are invaded by fibrous tissue serve as controls for the living cartilage grafts.

#### *Description of cadaver cartilage transplants*

The first section buried 6 months shows a septal cartilage graft with shrunken cells and normal staining matrix (Fig. 1). There is no invasion of the cartilage from the surrounding host tissue and the graft is apparently existing as a tolerated dead foreign body. In contrast to this the rib cartilage buried 9 1/2 months shows a beginning invasion of the cartilage by connective tissue and some absorption of cartilage (Fig. 2). This 9 1/2 month specimen represents the earliest section in my series showing fibrous tissue invasion. The septal graft buried 14 months (Fig. 3) is separated into 2 masses by ingrowing fibrous tissue. New blood vessels are present in the invading connective tissue and giant cells are scattered at intervals near eroded edges of cartilage. There is also an area of calcification, or early bone formation in the center of the cartilage graft.

There are 2 specimens buried 18 months (Figs. 4-5). One is rib cartilage and the

other septal cartilage. Both of these grafts show invasion by fibrous tissue and partial absorption. The oldest section (Fig. 6) buried 24 months is septal cartilage and also shows invasion by fibrous tissue and absorption. There is a small area of bone formation along one edge of the graft which probably represents altered cartilage, since lacunae can be demonstrated in the calcified substance. Numerous small cavities are present in the cartilage occupied by giant cells, large endothelial cells, fibroblasts, and blood vessels.

*Summary of findings in pickled cartilage grafts.* The grafts remain after transplantation as tolerated dead foreign bodies for about 9 1/2 months. From this time on the surrounding host tissues invade the foreign cartilage and very slowly absorb portions of the cartilage. This process, however, is very gradual and the bulk of the graft is still present 2 years after transplantation. The 14 month and 2 year specimens showed areas of calcification or early bone formation.

*Description of living autogenous rib cartilage transplants.* The 5 sections buried from 6 months to 2 years all appear as normal living cartilage (Figs. 7-11). They are surrounded by a dense connective tissue capsule and there is no evidence of invasion or absorption of the cartilage by the surrounding host tissue.

The specimen, buried  $4\frac{1}{2}$  years (Fig. 12), shows a large segment of normal appearing cartilage with a free space in its central portion. A part of this central space is occupied by bone which extends lengthwise through the center of the graft, and at one point communicates with the surface at the side of the graft. I believe that this condition occurred the following way, after transplantation of a large block of cartilage, the peripheral portions of the cartilage are able to obtain better nourishment from the surrounding tissues than the more remote central portion. The central portion, therefore, becomes devitalized, or actually dies from lack of nutrition, and is transformed into bone. The bulk and shape of the cartilage graft is not changed, and the peripheral portion of the graft, which obtains adequate nourishment, remains as living cartilage. The bone formation, therefore, represents a degeneration at the core of the graft, where the cartilage failed to survive because of nutritional insufficiency. The specimen of cartilage buried 6 years (Fig. 14) appears as normal living cartilage with no evidence of fibrous tissue invasion or absorption. The surrounding connective tissue is in close contact with the cartilage and on one side gives the appearance of slightly penetrating the external surface of the cartilage. This cartilage graft, however, was scraped with a scalpel before insertion in the nose, and I believe that the surrounding host tissue merely occupies the small depressions formed in the cartilage by the scraping of its external surface. The failure of the host connective tissue to penetrate more deeply at these favorable entry points is further evidence of the surviving power of autotransplanted rib cartilage.

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- 4 FISCHER, E. Ueber Transplantationen von organischem Material. *Deutsche Ztschr f Chir*, 1882, 17 362
- 5 GILLIES, H. O. *Plastic Surgery of the Face* Pp 13-14 London Oxford University Press, 1920
- 6 KOENIG, F. *Berl klin Wchsch*, 1896, 51 1120
- 7 LOEB, L. Autotransplantation and homotransplantation of cartilage in guinea-pig. *Am J Path*, 1926, 2 111
- 8 MANNHEIM, A., and ZYPKIN, B. Free autoplasic cartilage transplantation. *Arch f klin Chir*, 1926, 141 688, abstr in *J Am M Ass*, 1926, 87 2132
- 9 NAGEOTTE, J. *The Organization of Material in Its Relation to Life*. Paris Masson & Cie, 1922
- 10 NELATON, C., and OMBREDANNE, L. *La rhinoplastie*. Paris G Steinheil, 1904

- 11 NEUFELD HAROLD and HIRSCHFELD S The Transplantation of Tissues Pp 205-213 New York D Appleton & Co, 1923
- 12 NICOLIS P Esperimenti di innesto di cartilagine fissata nel rcone e di sostituzione di parti scheletriche con cartilagine fissata Arch per le sc med 1927 49 689
- 13 OLLIER L Traite experimental et clinique de la regeneration des os et de la production artificielle du tissue osseux Paris V Masson & fils 1907
- 14 PEER L A Cartilage transplanted beneath the skin of the chest in man Arch Otolaryngol 1938 27 42-58
- 15 IEFER L A and PADDOCK R Arch Surg 1937 34 268
- 16 PIERCE G W and O'CONNOR G B Ann Otol Rhinol & Laryngol 1948 June
- 17 TOLETTINI B Experimental growth of bone and cartilage grafts Arch ital di chir 1922 1923 6 170
- 18 PRUDEN T MITCHELL Am J M Sc 1881 82 360
- 19 VON MANGOLDT Arch f klin Chir 1899 59 9 6
- 20 ZANN F W Ueber das Schicksal der in den Organismus implantierten Gewebe Virchows Arch f path Anat 1884 95 369





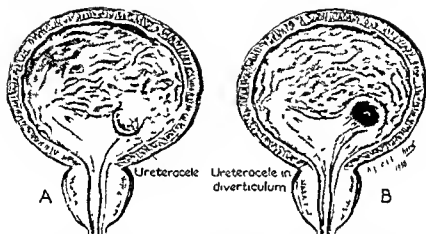


Fig. 2. (Case 9) Ureterocele in a diverticulum of the urinary bladder. A Ureterocele seen during the time of ejaculation protruding in a balloon shape with its minute ureteral orifice at the edge and lying in front of the trigone of the bladder. The ureteral orifice on the opposite side of the trigone is normal in shape, size, and position. B The same case showing the diverticulum of the urinary bladder during systolic contractions of the ureter in which the balloon of the ureterocele has been retracted inwardly and the ureterocele hides from its normal protruding position in the bladder.

*The Modern Surgical Treatment of Ureterocele —Robert C. utter.*

# THE MODERN SURGICAL TREATMENT OF URETEROCELE

ROBERT GUTIERREZ, A B , M D , F A C S , New York, New York

FOR the practising urologist there is no subject of greater interest and importance than a knowledge of the surgical anomalies of the ureter commonly met with in everyday urological practice. Some of these anomalies may affect function little if at all during the early years of life, yet at a later period may become a source of disease and misery to the patient; their true nature may remain unrecognized by the general surgeon or practitioner, symptoms may mislead in diagnosis, unnecessary and irrelevant operations be performed, and neglect of the true condition even lead to a fatal outcome. It is thus evident that the early recognition and treatment of such an anomaly as a ureterocele is a matter of vital importance.

It cannot be too often repeated that in all cases of urinary disturbance in which the symptoms are obscure, as is frequently the case in attacks of pain in the kidney, bladder or ureter, with urgency, frequency, dysuria, and polyuria of unknown causation, as well as in cases in which urinalysis reveals the presence of pus, blood, or bacteria, a cystoscopic examination with urographic studies is indispensable. The data thus obtained may at once reveal that the cause of the trouble lies in some hitherto unsuspected anomaly of the ureter at the point where it opens into the bladder.

Not the least interesting of the pathological findings that may be brought to light by the cystoscope is the ureterocele, often spoken of as the cystic dilatation of the ureter in its intravesical portion. The discovery of pathological changes at this point may promptly account for symptoms higher up in the urinary tract, such as pain in the kidney region, hemorrhage, suppuration, colic, associated with crises of pyelitis and pyonephritis, with chills and fever. Urographic examination in such cases may disclose urinary stasis with hydro-ureter and hydronephrosis.<sup>1</sup>

The picture presented by this so called cystic dilatation is so characteristic that it can seldom be mistaken or confused with any other pathological condition. It thus furnishes the most striking proof of the value of early cystoscopic and urographic diagnosis, since the surgical removal of this obstructive ureteral swelling is now generally accomplished quite easily, if taken early, making it possible to save, by modern conservative treatment, many a kidney that would in the past have been sacrificed through incorrect diagnosis and consequent neglect.

## DEFINITION

By the term ureterocele is understood the cyst-like formation that arises when the vesical end of the ureter, usually after an abnormally long course through the mucosa, becomes stretched out into an abnormal dilatation as the result of narrowness of the orifice, or a congenital or acquired stenosis of the orifice has led to such a dilatation of the ureter within the bladder. The outer covering of such a formation is composed of bladder mucosa, which makes it easily distinguishable from the relatively rare and insignificant prolapse of the ureteral mucosa into the bladder, an eversion of ureteral mucosa through the ureteral orifice, in which case the covering membrane is clearly of another character, ureteral, not vesical. In the early cases reported this distinction appears not to have been made.

The form and size of the sac constituted by the dilated end of the ureter may vary widely, the simplest form being that of a balloon that protrudes during ejaculations, with an opening at its tip, which is the orifice of the ureter, herniating forward into the bladder. The various authors report cysts from the size of a hazelnut to that of an orange, or even 5 to 6 centimeters in length; in infants they have sometimes filled the entire bladder. These ureteroceles may be round, elongated, or flat, and may be either open or closed. If small, a

<sup>1</sup>Gutierrez, R. In Cabot's Modern Urology, 3d ed., vol 2, chap. XI, pp. 374-509. Philadelphia: Lea & Febiger, 1936. J. Am. M. Ass., 1936, 106: 183-189.

ureterocele may have no effect upon the passage of urine, or may announce its presence only when the bladder, in contracting, presses the little tumor against the internal ureteral orifice. But if the dilatation of the ureterocele reaches the vesical orifice or the internal urethral orifice, it will act like a valve or an obstruction of a median lobe of the prostate and will cause retention and other definite urinary disturbances. The entire upper urinary tract is then liable to suffer through back pressure and infection due to the hydraulic retention of urine. While in simple cases taken early, treatment may be accomplished by way of the urethra, in the more advanced and neglected cases removal of the entire ureter and kidney by a total ureteronephrectomy may become necessary.

The purpose of this paper, therefore is two fold first to call attention to the importance of this clinico-anatomopathological entity, as well as to the variety of modern surgical problems that have been so greatly misunderstood in the past on account of the mixed symptomatology, the lack of proper diagnosis and the absence of any standardized type of treatment and second, to report, at the same time, a series of 15 cases of ureterocele which the author has had the opportunity to diagnose and treat and which have served as the basis of this study. All of these cases have been observed by the author personally and collected from his office files. 8 of them having been private cases diagnosed and treated by electrofulguration and cystoscopic manipulations at the office, while the other 7 cases were observed and treated by him in the clinics of three New York hospitals.

#### HISTORY AND LITERATURE

Like other anomalies of the urinary tract the earliest findings of ureteroceles were made at autopsy. Lechler in 1834 was the first author to give a clear account of such a structure which however he and the attending surgeon mistook for a double bladder. This case was in a 3 months old infant who after several attacks of screaming pain one of which was observed to have ceased abruptly when external manipulation caused sudden ejaculation of urine died within a few days

of what was believed by the surgeon to be peritonitis. Autopsy revealed however, no indications of any peritoneal inflammation but showed that within the bladder of the child and filling its whole cavity was a "second bladder," highly inflamed, upon the lower surface of which could be seen, close to the true bladder neck, the orifice of the ureter. "The inner bladder," says Lechler, "was a formation peculiar to itself, for it alone was inflamed and no other organ, not even the mucous membrane of the bladder, took any part in it." It is of interest to note that in this case, as in many other cases of ureterocele since reported, there were other congenital malformations, the left kidney being twice the size of the right, and being drained by 2 ureters, both of which had undergone torsion.

Engelsh, in 1898, was the first investigator to delve into the subject and bring to light not only the case of Lechler, which was buried in ancient archives, but also some 14 others to which he added one case of his own. In 6 of the 15 cases that he collected the ureter was blind in 9 it was patent. In practically all of these cases it was reported that other anomalies existed. Among them was the case of Lilenfeld (1856) in a man of 65 in which the dilatation was referred to as 'a second bladder which projected into the lumen of the urethra.' Wrang's case (1870) was in a little girl in whom the left kidney had 3 hilums and 3 ureters, one of which corresponding to a single calyx bulged out into the bladder in a sac the size of a hazelnut. Weigert (1886) reported 2 cases in one of which the subject was a stillborn male infant with a cleft palate and harelip as well as supernumerary fingers on both hands, the right ureter formed the ureter over while the left emptied into a seminal vesicle. Other early cases in Engelsh's collection were those of Bostroem (3 cases) in 1884, Geerdts in 1887, Caillé in 1888 and Grosplik (1898). Frey in 1897 found 2 stones in one such ureter, and was the first to suggest, in a report to the Royal Society, that calculi might be the primary cause of such a dilatation.

Lipmann Wulf in 1898 appears to have been the first to observe such a case cystoscopically, but he called it a tumor of the bladder until he found at operation that it

was a cystic dilatation of the ureter Groszlik in 1901 first correctly diagnosed a ureterocele through the cystoscope Cohn in 1904 was the first surgeon to carry out an open operation on the basis of a correct cystoscopic diagnosis

An important thesis on the subject was written in 1913 by Marmier, who in a study of 42 cases found 38 that showed evidence of stenosis of the ureteral orifice Some of these cases, from Albarran, Pasteau, Bazy and others, are discussed in detail

In these radio-urographic days with more modern means of investigation, additional progress has been made in the clinical diagnosis of ureterocele, the presence of which can now easily be discovered in a good intravenous urogram, where the cystic dilatation of the intravesical portion of the ureter may be seen as a filling defect in the cystogram

There is no doubt of the definite progress that has been made in recent years concerning the treatment and prognosis of this clinico-urologic entity, particularly since Edwin Beer in 1910 introduced the use of the Oudin high frequency current for the electrofulguration treatment of vesical tumors In later years this ideal method has been applied with even greater success to the prevention and correction of ureterocele, as well as of other obstructing conditions of the lower urinary tract<sup>1</sup>

As regards terminology, we find that bladder cyst or even double bladder was the current expression in the earliest cases It was Englisch who in 1898 introduced the term "cystic dilatation of the vesical end of the ureter," an expression which, however cumbersome, obtained the greatest vogue, especially in Germany and France Certain authors (Fenwick, Blum), however, have pointed out that the name cyst is misleading since the dilatation has not the structure of a true cyst Fenwick (1903) proposed that the term "ballooning of the ureter" be adopted as the most suitable Blum, who reviewed the literature up to 1920, by which time 100 cases had been reported, states that "intravesical prolapse

of the ureter" was a favorite name, the differentiation between such prolapse and a ureterocele not having yet been clearly made The name *ureterocele* was first used by Leshnew in 1912, and that of *intermittent ureterocele* by Ottow in 1914 Kotzenburg (1914) spoke of ureteral cysts, and Pleschner (1917) of "phimosis of the ureter." The superior value, however, of a single word like *ureterocele*, to express so characteristic a formation as this disease entity, is obvious, not to mention the greater descriptive accuracy of this term

#### CLASSIFICATION

In making a study of ureterocele, we cannot fail to note the number of different types that have been observed and reported in the literature All these are in reality the expressions of a single disease entity, the difference being that in some the pathological condition is more advanced than in others In other words we must believe that, just as in tumors of the bladder, the growth begins with a small excrescence like a pearl upon the bladder wall, at the orifice of the ureter, and that this minute structure gradually, as the result of infection, exaggerated hydraulic pressure or other pathological condition, progresses to the stage of a dilatation of much larger dimensions and takes on a cystic character This hydraulic and cystic dilatation of the intravesical portion of the ureter is in many cases the result of a congenital malformation or obstruction at the ureteral orifice, which sooner or later will produce a definite interference with the proper drainage of the kidney and ureter. Some of these ureteroceles reported in the literature, as well as some observed by the author himself, have been as large as an orange, occasionally even occupying the whole bladder

We think, therefore, that it may be useful to classify ureteroceles according to these different clinico-pathological stages and to point out the variations which they may exhibit, since not all develop along precisely the same lines, owing to the variety of factors that play a part in their formation Thus, some of them may never result in any hydronephrosis at all Others, in which the lesion is not discovered until a late stage has been reached, may go so

<sup>1</sup>Gutierrez, Robert Transurethral treatment of bladder neck obstructions Endoscopic prostatic resection In *History of Urology*, vol II, chapter V, 237-286 Baltimore Williams and Wilkins Company, Surgery of the seminal vesicles, ampullae and vasa deferentia In *Oxford Loose-Leaf Surgery*, vol III, Pt 2, pp 301-309 New York Oxford University Press, 1935

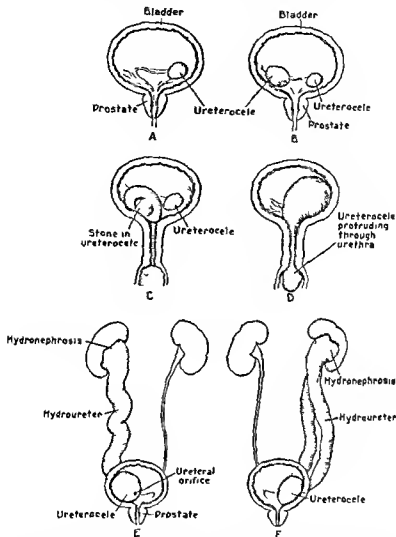


Fig 1 Classification of the most common varieties of ureterocele. A simple unilateral ureterocele. B simple bilateral ureterocele. C bilateral ureterocele containing stone and producing complete retention of urine in a female. D ureterocele prolapsing through the urethra and protruding beyond the urethral meatus commonly observed in males. E ureterocele with minute ureteral orifice producing urinary stasis with marked hydro-ureter and hydronephrosis representing the final stage of the obstructing type of uropathology of the upper urinary tract. F ureterocele with reduplication of the ureters and kidney pelvis with hydro-ureter and hydronephrosis.

far as to produce functionless hydro ureters and hydronephrosis. In such cases it is too late for any conservative procedure to save the damage resulting in a kidney which might have been restored to usefulness if the condition had been recognized earlier.

I have accordingly collected nine different types which will illustrate some of the more common varieties that I have had occasion to see in the routine course of urological practice and which are met with in the literature. These are shown in Figures 1, 2, 3, and 4.

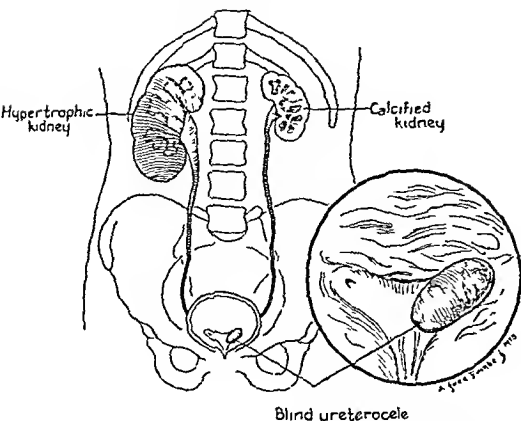


Fig 3 Drawing from radio-urographic films and cystoscopic data of Case 8, showing a blind left ureterocele, with complete calcification of the corresponding functionless left kidney

Figure 1 comprises 6 of these, as follows A, Simple unilateral ureterocele B, Simple bilateral ureterocele These two forms may be observed at any age and in either sex, and are the commonest of all C, Ureterocele ballooning inside the bladder and containing a stone. This may cause complete retention, as occurred in one of the cases herewith reported D, Ureterocele prolapsing through the urethra, and protruding beyond the meatus—a type that has recently been stressed by Grandineau, Davis and Owens, Campbell, Laffitte, Boeckel and others These last two types are more commonly observed in females, because of the shortness of the urethra E, Ureterocele with hydro-ureter and hydronephrosis—an advanced stage caused by the ureterocele obstructing the mouth of the ureteral orifice and interfering with normal drainage F, Ureterocele in an anomalous condition of the upper urinary tract, in which 2 ureters open at the level of the ureterocele, producing hydro-ureter and hydronephrosis in a case of double ureter and double kidney, thus constituting an anomaly in a twofold sense In cases of this type of anomaly, sometimes one of these double ureters opens normally into the bladder, while the other independently herniates to form a ureterocele.

In addition to this group of six, there are three other types not quite so frequently observed, which are illustrated in Figures 2, 3, and 4 In the first of these, the ureterocele

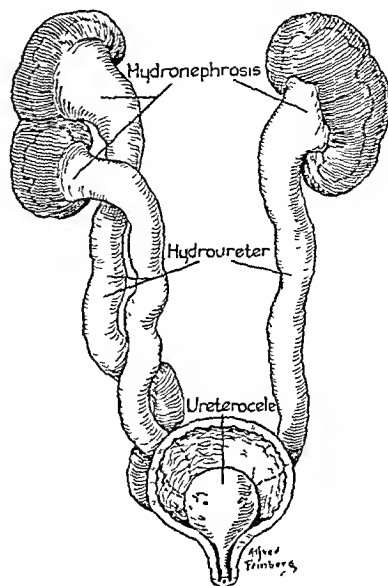


Fig 4 Ureterocele in a female child who was admitted to the hospital in uremia Postmortem examination showed the enormous size of the ureterocele blocking the entire passage of urine, thus producing hydro-ureter and hydronephrosis This fused type of megaloureterocele gives the impression of having loosened the entire mucosa around the area of the trigone of the bladder, causing this to protrude through the urethra in a ballooned cyst-like shape. This case also illustrates duplication of ureter and kidney pelvis on one side with bilateral pyouretero-hydronephrosis (Modified drawing after Campbell)

opens into a diverticulum of the urinary bladder in such a way that the ureteral orifice debouches within the fundus of the diverticulum, occupying one angle of the trigone (see Fig 2, A and B). Here the ureterocele, clearly showing the ureteral orifice on its tip, balloons from the diverticulum into the bladder during ejaculation or upon rhythmic contractions of the ureter, or during inspiration and expiration, when it can be observed cystoscopically as it alternately appears and disappears. We reported this type of case in 1928 in connection with 55 cases of diverticulum of the urinary bladder and have had the opportunity more recently of seeing another case of the same type. The next type is the blind ureter forming a ureterocele such as has been reported in the literature by Englisch, Kelly, Papin, Dourmashkin, Chivella and others, and of which I have seen one case, in an elderly female patient, in whom there was also

complete calcification of the functionless corresponding kidney (Fig 3) Finally, there is a fused type, or megalo ureterocele, in which the bladder mucosa in the area of the trigone is loosened up and forms a single balloon, like a bladder inside of another bladder, in which the mouths of the anomalous ureters are found, and which has herniated through the lumen of the urethra (Fig 4)

We see, therefore, that although the condition known as ureterocele is anatomopathologically a unit, a single entity, it can, nevertheless be subdivided and classified according to these different clinical types Such a classification will emphasize the importance of a condition which, if left untreated in its earlier stages, may lead even to grave disintegration of the kidney itself and in some instances to fatal uremia

From a histological point of view, it is possible to establish a further classification into a mucous and a muscular type The sac of the ureterocele may be formed simply of vesical and ureteral mucosa and submucosa, in which case we may speak of a mucous type Or there may be present a layer of muscular fibers, sparse or occasionally abundant, in which case we may refer to a muscular type The mucous type is the more commonly observed, in the author's experience

#### ETIOLOGY

The pathogenesis of ureterocele has been widely discussed, and the most divergent opinions have been expressed with reference to the origin of these cystic dilatations

The theories for a long time turned largely about the question whether they were congenital or acquired, whether the stenosis at the ureteral orifice which characterizes nearly all ureteroceles has its origin in embryonal life and is the result of a malformation arising in the early stages of gestation, or whether it is an acquired condition secondary to some inflammatory condition, or due to calculus formation or infection reaching the ureteral orifice from some other part of the genito-urinary system or even from a distant focus elsewhere in the organism

The classic arguments for a congenital origin are (1) the relative frequency with which

ureterocele has been discovered in the very young, (2) the tendency of the condition to be bilateral, (3) the frequency with which other concomitant anomalies of the urinary tract are observed While most ureteroceles are probably of congenital origin, there is nevertheless complete evidence that they may occasionally be acquired Among grounds for the belief in such acquired origin is the familiar observation that, at any stage of life, cystitis may, by its gradual infiltration of the mucosa of the bladder and lower end of the ureter produce enough scar tissue about the ureteral orifice to provoke stenosis thus creating at least one of the prerequisites for ureterocele formation Many authors hold the view that inflammatory disease of the upper urinary tract, including stone formation and various infections stands in a causal relation to ureterocele It is a moot question today however, whether these are the causes or the result of the narrow opening and the ballooning of the ureter into the bladder

Among the works of early writers on the subject we find ureterocele attributed to various causes, among which may be mentioned (1) A gluing together of the walls of the ureteral orifice in fetal life, resulting in stenosis, or, in rare instances in complete closure, a "blind ureter," of which Dourmashkin has found 25 in the literature (2) An adhesion of the ureter under the blind ending in the bladder wall—a view which is supported by the fact that the deformity frequently affects only one side (3) A hypoplasia of the bladder and ureteral mucosa at the orifice of the ureter (4) An abnormally long submucous course of the ureter (5) A vertical course of the ureter through the bladder wall instead of the normal oblique course (6) An abnormal mobility and malformation of the trigone It has been argued by several authors that the increased pressure in such a ureter meets less resistance on the part of the bladder musculature than it would if it entered in the normal oblique direction, that in the latter case the physiological tension of the muscularis is sufficient to withstand the increased pressure and to prevent a dilatation at its lower end In other words the portion of the ureter that passes along immediately under

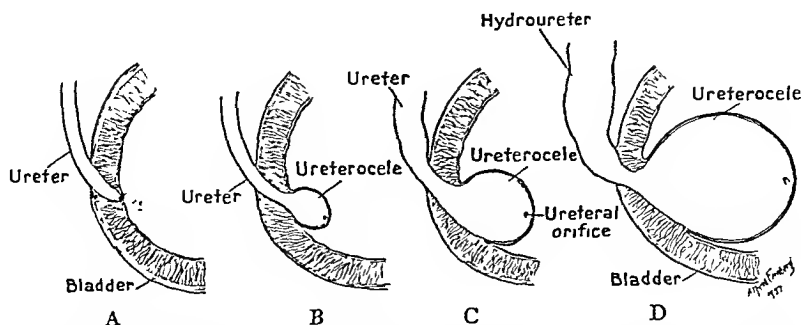


Fig 5 Theoretical pathogenesis of ureterocele The anatomopathological conception of the different steps in the mechanical formation of the ureterocele A, The ureter with its minute orifice piercing the bladder wall, with the dotted lines representing the first stage of the loosening up of the mucosa of both the ureter and the bladder, during ejaculation B, C, and D, the successive stages by which the ureterocele gains in size and balloons into the bladder D reveals the degree of obstruction and back pressure which ultimately produce hydro-ureter and hydronephrosis

the mucosa for a long distance, or perhaps in the submucosa, would remain outside the sphere of action of the vesical musculature, it would therefore give way more easily to the pressure within the ureter and so become projected with its mucosa into the bladder as a ureterocele (Fig 5) It would then go without saying that the cyst would grow constantly bigger and bigger and extend chiefly in the direction of the trigone, where it meets the least resistance

If we assume with Groslik a blind or nearly blind end to the ureter, due to a gluing together of the epithelium in early life, it is evident that the first result of urinary stasis in the upper segment will be dilatation of the ureter The greatest injury will occur in the portion of the ureter behind the bladder, since this is only loosely connected with its surroundings and offers the least resistance to increased pressure With reference to the effects on the 3 coats of the ureter, the changes occurring in the submucosa will be less than those in the mucosa, and those in the muscularis will be least of all, due to its resistance The result will be a dilatation behind the bladder, a protrusion between the muscularis and mucosa, into the bladder, both of these parts being bound together and running through the muscularis itself Thus, the ureter will assume the form of an hourglass, ballooned behind and before, but contracted at just the place where the muscularis is pierced

by the canal. The greater the resistance of the muscularis, the closer will be the contraction and the narrower the orifice.

Gottlieb, in a comprehensive article based on the careful study of 5 cases of his own and a critical analysis of 100 cases collected from the literature, points out that stenosis or stricture alone could not start a ureterocele; for if this were the only cause, the condition would be very much more common than it is It would appear that there must be a general inferiority (congenital) of the connective tissue, and especially that of Waldeyer's sheath, of the ureter, that an abnormally narrow orifice, *alone*, causes retrograde dilatation; while weakness of Waldeyer's sheath, *alone*, causes herniation of the ureter, but that neither of these factors alone can make a ureterocele Two factors are needed A constitutional inferiority of the muscle fibers would be congenital A stenosis might be either congenital or acquired, as through inflammation, stone, or tumor.

Chwalle studied ureteral buds in 3 month embryos, and described one in particular in which he found indications pointing to a congenital origin of ureterocele Papin is very sure that the condition is always congenital, and states that a ureterocele is only the lower segment of a hydro-ureter for which stenosis at the ostium is necessary Dardanelli regards a ureterocele as a sort of hernia He says that it is not merely a complication of hernia, but



that it is a hernia *sui generis*, with a symptomatology all its own, and that the peritoneum being in some cases very mobile and slippery causes the ureters to take a curved lateral direction toward the end of their course resulting in their displacement into the bladder. In the report of 13 cases Blumer found 10 of true congenital origin, of which 5 died of urinary infection in childhood. O'Connor and Johnson, in a recent study of 19 cases of ureterocele, concluded that this lesion was not due to an obstruction in the extramural portion of the ureter, nor was it due to atony of the ureteral wall, but to a combination of a congenital or developmental narrowing of the ureteral orifice, along with a congenital weakness of the connective tissue and muscular elements surrounding the ureteric meatus. Lavendera meets the objection of those who say that if these cysts were congenital they would appear earlier, by the reminder that the wear and tear of life as old age approaches causes congenitally defective organs to show weaknesses that did not appear in earlier years. Caulk is of the opinion that many ureteroceles are acquired and that they are not infrequently secondary to inflammatory processes, such as those occasioned by the passage of stones or by ulcers in this region or that they develop from ureteritis due to a renal lesion, such for example as tuberculosis. Another cause might be the faulty reimplantation of the ureter after a ureterovesical anastomosis. Pettillo holds the view that adhesions between the seminal vesicles and the ureter or between the broad ligament and the ureter cause a paralysis of the lower end of the ureter with subsequent loss of contractile power in this segment which in turn results in dilatation and protrusion into the vesical lumen.

It seems rather evident that both the two factors of stenosis and muscular weakness taken together lie at the foundation of ureterocele. The normal physiological action of the ureteral musculature is impaired by this anatomical weakness. Pyeloscopy studies of the upper urinary tract have revealed the continuous peristaltic waves that are present in the normal ureter. Any weakness or malformation in the intramural portion of the ureteral musculature would interfere with this

physiological dynamism and invite formation of a ureterocele.

The accompanying drawing shows the several stages by which a ureterocele would be formed as it is theoretically explained (Fig. 5). The longitudinal muscular fibers supplying the ureter are diverted to right and left like a fan at the point where the ureter enters the vesical wall leaving a weak spot in the bladder wall even in the normal individual. Given a muscular tissue of inferior constitution with few longitudinal fibers, or even none at all in certain cases we have a ureteral wall composed almost solely of mucosa and submucosa. Such a canal easily falls a prey to dilatation and hernia as the peristaltic action above exerts continuous hydraulic pressure downward into the bladder.

The pathogenesis of ureterocele as a disease entity may, accordingly, be summed up by saying that it is quite similar to that of diverticulum of the urinary bladder, and that it has much of both the congenital and the acquired factors in its origin. The paramount factors in the formation of ureterocele thus appear to be (1) the congenital narrowing of the intravesical portion of the ureter, (2) congenital weakness or absence of the longitudinal muscle fibers of the terminal portion of the ureter, resulting in abnormal mobility of the trigone, (3) loosening up of the vesical mucosa at the point where the ureter enters the bladder, (4) disturbances of dynamism and hydraulic pressure within the ureter, (5) lack of drainage due to obstruction in the lower ureter, (6) presence of infection or other concomitant pathological lesions of the ureter and bladder.

Finally, we cannot overlook the fact of the important rôle played by other anomalies of the ureter in the causation of ureterocele, as is clearly evident in cases in which ureteroceles are formed from an ectopic or supernumerary ureter which opens anywhere in the bladder or urethra. Nor can we ignore the fact that cases of ureterocele in double ureters and double kidney pelvis with hydro-ureter and hydro-nephrosis in one of the two ureters are quite commonly observed (Fenwick, Kolisko, Lilienfeld, Caille, Neelsen, Bostroem, English, Gutierrez, Campbell, Lazarus, Muschat,

Young, and many others). All these associated congenital malformations of the ureters prompt us, therefore, to consider the rôle of the anomalous ureter as an important factor in the pathogenesis of ureterocele

#### PATHOLOGY

In the beginning stages a ureterocele is usually such a slight lesion that nothing is observable beyond an insignificant dilatation of the intravesical portion of the ureter, and there are no symptoms to call attention to its existence. Such a ureterocele would, therefore, be an accidental finding during routine cystoscopic examination, at operation, or autopsy, of the presence of which the patient had been wholly unaware. In other cases, however, there are very severe disturbances of the entire urinary system. Clinically there may be dysuria, frequency of urination, "colic," ureteritis, pyelitis and pyelonephritis; or difficult and painful micturition, with chronic total or partial retention, or again, under conditions that reduce tension, such as lying down, there may even be incontinence.

The position of the ureterocele in the bladder has much to do with the severity of the symptoms. If it is small and lies relatively far back from the bladder neck, and is limited to one-half of the trigone, there may be no urinary disturbances. If, however, it is so placed that the stenosis of the ureteral orifice is of high degree or if the pull of the abnormally pedicled ureter from time to time causes temporary complete abolition of its lumen, there occurs, first, a urinary stasis in the portions of the urinary tract which lie above the obstruction, which results in a dilatation of the upper ureter and the renal pelvis. If neglected, this stagnation will in course of time lead to an enormous extrarenal hydronephrosis and, of course, a corresponding hydro-ureter. However, in some cases, in which the pressure within the ureter and the kidney pelvis is very strong, and yet the pelvis has not the capacity to yield outwardly by a dilatation, the result is a hydronephrotic atrophy of the kidney parenchyma, through which the kidney is converted into a huge thin-walled sac, constituting an intrarenal hydronephrosis or pyonephrosis. As the ureterocele is espe-

cially prone to develop in a urinary system in which there are double ureters, it not infrequently happens that a dilatation appears in one of the duplicate organs that drains only a portion of the kidney from which it proceeds. In such case only that portion of the kidney will dilate, and the other part of the kidney may remain in a sound condition, at any rate for a long time.

In very far advanced cases, if the ureterocele has reached a high degree of dilatation and assumed a considerable size, then the process as a rule not only has an injurious effect on the entire upper urinary tract of that side but will also occasion changes within the bladder. The natural course of the growth of the ureterocele is along the trigone into the region of the internal neck of the bladder. In addition to this, it happens that the abnormally lengthened submucosal course of the ureter always brings it into a rather close proximity to the internal vesical orifice. If it has grown so far as to reach this, difficulties in emptying the bladder at once arise. The ureterocele lies over the bladder outlet like a valve, and, acting like a foreign body, causes the patient to suffer from edema and polyposis of the vesical orifice, cystitis with increasing urgency, dysuria, and bladder tenesmus.

In extreme cases an attack of complete retention may occur, which may again disappear if the cyst shrinks or bursts, only to reappear according to changes occurring in the latter. But there may also be all grades of incomplete retention and residual urine, associated with painful urinary disturbances. The bladder wall always shows, and usually quite early, a trabecular muscular hypertrophy representing a compensation for the enormously increased work on the part of the detrusor muscle, increased by dysuria.

If the ureterocele extends so far that the orifice of the healthy ureter is compressed and becomes closed upon contraction of the bladder, then a high grade stagnation of urine occurs in the other kidney also, which may in very advanced cases lead to complete anuria. Such cases are not very infrequent in the literature, so that despite unilateral formation of the ureterocele, a high grade hydronephrosis may develop on the other side as well.

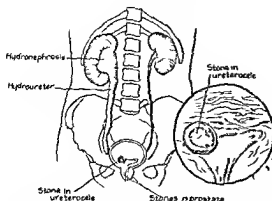


Fig 6 Schematic drawing from Case 4 illustrating a right ureterocele complicated with stone and multiple prostatic calculi. Diagnosed cystoscopically and treated satisfactorily by simple fulguration of the meatus of the ureterocele and further cystoscopic treatments with dilations of the ureters and kidney pelvis lavage.

As soon as the factor of infection is added to the renal and ureteral stasis the entire picture changes quite radically, and we observe signs of acute and chronic cystitis, ureteritis and pyelitis. Conditions that are at first simply catarrhal may then turn into very severe inflammations, accompanied by hemorrhagic and ulcerative complications. From simple dilatation of the ureter and kidney pelvis there may arise the worst forms of pyelitis and pyonephrosis. In some instances for lack of drainage and due to infection stones are readily formed in the ureterocele (Fig 6).

In some cases chronic masked forms of mucosal inflammation and bulbous edema are found upon cystoscopic and macroscopic examination, to be cases of chronic cystitis accompanied by glandular and follicular involvement. This chronic inflammatory condition of the bladder mucosa inevitably proves eventually a source of contamination of the sound kidney, through vesico-ureteral reflux so that the entire urinary system becomes diseased and incapable of performing its proper functions.

The prolapse of the ureterocele through the female urethra must be regarded as a special variation of the anatomical and pathological picture (Fig 4). Upon straining to urinate and thus to get rid of the foreign body, that the patient feels within the bladder the blad-

der muscle presses the cyst outward through the dilated urethra, and there is then seen the picture of a tumor lying in front of the external meatus which can with little difficulty be pushed back into the bladder temporarily. Upon the prolapsed portions of mucous membrane there are often seen signs of chronic inflammation, such as hornification of the epithelium and leucoplakia. Several of the earliest cases of ureterocele reported were of this nature, in young female children. All the early cases of this kind were fatal, the entire urinary system being invariably found in a state of inflammation, with abscessed kidneys, and the like, from ascending infection that had arisen from the sloughing off of the invaginated mucosa within the meatus.

#### DIAGNOSIS

In early times, before the arrival of the modern urographic and cystoscopic era the diagnostician had to depend on the symptomatology, which in reality has nothing characteristic about it to differentiate it from "cystitis" or other irritant conditions of the bladder. These symptoms may be due to infection or to obstruction. In some cases there may indeed be no symptoms at all in the early stages of the dilatation. We know that a large number of cases in the literature gave no trouble during life and were diagnosed only at postmortem. Symptoms due to infection may consist of the usual dysuria, frequency, pyuria and hematuria that characterize cases of cystitis. Symptoms due to obstruction or stricture of the ureteral orifice consist of attacks of ureteral and renal colic and the usual manifestations of retention in advanced cases that have gone on to hydro-ureter and hydronephrosis. But there is nothing characteristic about these symptoms, and our main dependence for diagnosis must be placed on the cystoscopic and urographic findings. Chromocystoscopy is also of value making it possible to watch the ejaculations more clearly. It is fortunate that by these means we are able today to recognize and interpret these findings when the ureterocele is in its early stages.

When a ureterocele is still in its initial stage, it is observed cystoscopically, that immedi-

ately before the ureteral ejaculation occurs, a flattened tumor is formed at the level of the ureteral orifice, resting against the bladder wall, where it obliquely follows the direction of the ureter. At this moment the submucous wall of the ureter becomes transparent, the ureteral orifice, surrounded by this encircling prominence, dilates, then, at the moment of ejaculation, it retracts and the dilatation disappears, to return again with the next ureteral contraction.

In the second stage, the little tumor has become a permanent projection into the bladder. It presents the appearance of a rounded prominence, smooth and shiny, with a broad base covered with healthy or slightly inflamed mucous membrane, on the surface of which a fine tracery of vessels can be observed. On its summit the round and contracted orifice can as a rule be seen. Sometimes this orifice is absent, either because it is really lacking or because it is dissimulated between the posterior wall of the cyst and the wall of the bladder. When the cyst is distended, causing its walls to become thin, it takes on an appearance of transparency and can be transilluminated, especially if the cystoscope is placed deep within the bladder, close to the ureterocele, just as a flash light is applied to a hydrocele. The same changes can be observed with the rhythmic movements of the ureter as in the first stage of its evolution, but now, after the ejaculation, the cystic formation does not entirely disappear as it did before. In one of my cases these alternations appeared every 30 seconds.

In the third stage of development, the ureterocele becomes more or less pedunculated, its distended walls have become inert, its size remains constant, it prolapses more or less into the bladder toward the internal orifice of the urethra, with which it has a tendency to make connection. One characteristic observed is that if the structure is touched with the tip of an instrument, it reacts like a rubber ball, with a momentary depression that disappears when the pressure is removed.

When the condition of ureterocele is discovered on cystoscopic examination, it is always wise to catheterize the ureters whenever possible; and also to take a plain roentgeno-

gram with the catheters and instrument in position as well as retrograde uretero-pyelograms, not only for the purpose of confirming the diagnosis of ureterocele, but also to rule out concomitant anomalies or other pathological conditions of upper urinary tract (Fig 9).

In the differential diagnosis, ureteroceles are not likely to be confused with polyps, since the only character they have in common is their site. Polyps are not transparent, their size is constant, their pedicle is long and thin, and the urine is seen to escape around the tumor and not at its summit. Nor will a stone wedged in the lateral wall of the bladder or a benign tumor invested with a layer of fibrinous exudate on its surface be readily mistaken for a ureterocele. The only real confusion will lie between the latter and a prolapse of ureteral mucosa into the bladder. One way of recognizing such a prolapse, which after all is not very common, is that it can ordinarily be reduced by pressure on its summit. It has also been observed that in prolapse the movements are only in and out, while in cystic dilatation there is also an expansion and a retreat like that observed in an aneurysm. Prolapse mostly occurs through an enlarged ureteral orifice, while the ureterocele forms a pocket closed on all sides and opening into the bladder by an orifice that is ordinarily much contracted. Marked edema with swelling of the intravesical portion of the ureter when produced by impacted ureteral calculi is easily differentiated, since it is readily observed that when the ureteral stone is dislodged and expelled, the edema that surrounds the mouth of the ureteral orifice finally subsides. Ureterocele must also be differentiated from cyst of the prostate, cystitis and ureteritis cystica, and other pathological conditions of the urinary bladder, such as hypertrophy of the interureteric ridge or "floating trigone," pedunculated solid tumors and diverticula of this viscus. Moreover, when the ureterocele prolapses from the meatus of the urethra and becomes an extravesical ureterocele, it must be differentiated from polyps, papilloma, prolapse of the urethral mucous membrane, caruncle, condyloma, peri-urethral abscess of Skene's glands, carcinoma, and other common pathological conditions of female urethra.

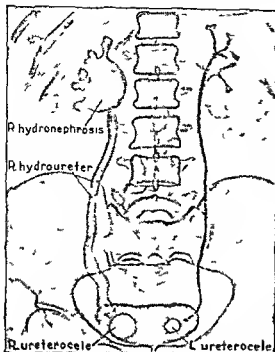


Fig 7 Drawing from an intravenous urogram revealing the two round filling defects in the area of the bladder with marked hydro ureter and hydronephrosis on the right side. Filling defects of this type in a cystogram are pathognomonic of ureterocele

Finally, intravenous urography is of great help in the diagnosis of ureterocele and should be used as a routine method of examination, since in a good film one can visualize the condition of the upper urinary tract and at the same time readily detect any filling defect in the cystogram appearing as a superimposed round shadow of the opaque substance retained within the sac or balloon of the ureterocele (Figs 7 and 8). When this type of shadow is present in the cystogram, it should be considered as a pathognomonic urographic sign for the diagnosis of this condition. However, this beautiful urographic finding should always be checked cystoscopically in order to rule out uric acid or cystine stone, diverticulum, and bladder tumor.

#### TREATMENT

Treatment consists of medical and surgical measures

**Urological measures** These will include cystoscopic dilatations of the mouth of the ureterocele with ureteral bougies and catheters and irrigation of both the renal pelvis and ureters with antiseptic solutions, such as silver nitrate, acriflavine or rivanol dextrose 1:2000. The dilatations should be done at weekly intervals and continued until a No. 9, 10, or 12 catheter can be readily passed to the kidney pelvis without obstruction. In this way an improved drainage is assured and the degree of infection reduced, the constant irritation of the bladder wall is relieved, and the dysuria and other urinary symptoms diminished, resulting in a general amelioration of the patient's condition.

**Surgical treatment** According to the stage of evolution of the ureterocele, minor transurethral surgical measures or more radical open procedures are indicated. *Minor surgical measures* consist of transurethral treatment that can be carried out cystoscopically. This may be either one of two kinds: (1) simple fulguration with a point electrode, (2) ureteral meatotomy carried out by cutting with minute scissors or knife electrode.

When more radical operative procedures must be considered, these again fall into two main groups, according to the pathological lesion present: (1) cystostomy and (2) combined ureteronephrectomy.

(1) If the ureterocele is of large size or is accompanied by infection, tumor, stone, or other complication, cystostomy must sometimes be done for its complete removal. (2) If the ureterocele is of long standing and obstruction has reached such a high degree that the ureter and kidney have been severely compromised, usually resulting in hydro ureteronephrosis, then combined ureteronephrectomy may become necessary.

*Minor transurethral surgical procedures* may be described as follows:

A. In simple unilateral ureterocele, when the cyst is small and without complications, the best procedure is simple fulguration of the ureteral orifice carried out cystoscopically. A fulgurating point electrode is inserted in the ureteral orifice of the ureterocele, the high frequency current is applied and the entire surface of the ureterocele is destroyed by ap-

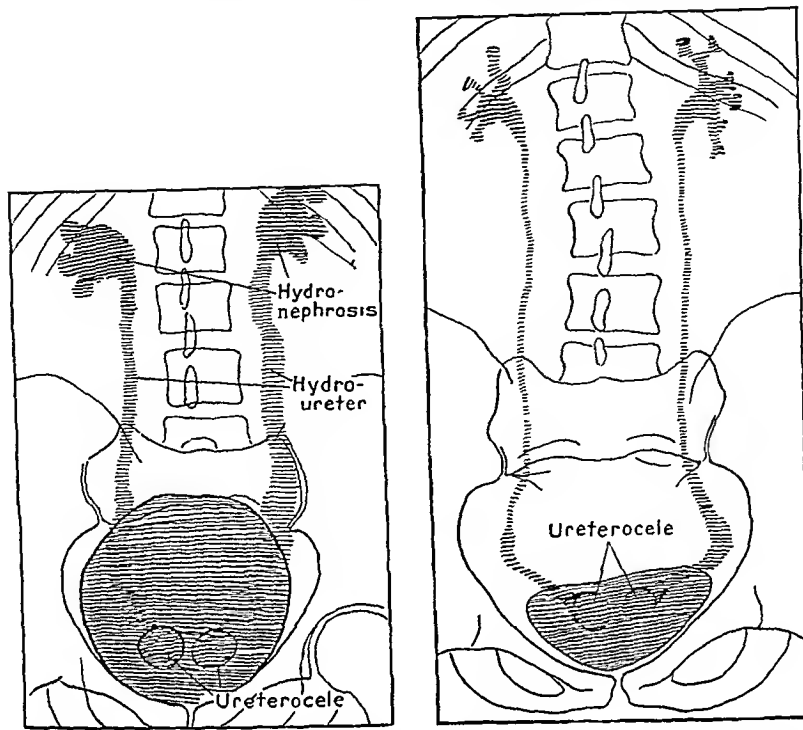


Fig 8 Drawings from intravenous urograms of bilateral ureteroceles in two adult female identical twins (Riba's case) A, at left Note the obstructing pathology of the upper urinary tract, with bilateral ureterocele, a slight degree of hydro-ureteronephrosis and evidence of megalo-bladder B, Drawing from the intravenous urogram of the second twin, showing the presence of bilateral ureteroceles in the cystogram

plication of the electrocoagulating current, under cystoscopic control. The simplicity of the procedure and the good results uniformly obtained commend this above all other procedures. Fulguration will also permit the passage of a stone if any happens to be impacted in the intramural portion of the ureter or within the ureterocele, as occurred in 2 of my cases reported here. The patient should receive bladder irrigations at least twice a week after the fulguration; then after sloughing of the fulgurated tissue is complete and healing has taken place, which will be in about 2 or 3 weeks, dilatations of the ureters and kidney pelvis lavages should again be carried out in order to secure perfect drainage and prevent constriction of the mouth of the ureteral orifice. The scar resulting from this operation provides as a rule a good sphincter at the mouth of the ureter, and thus prevents vesicorenal reflux.

When the opening of the ureteral orifice is so minute that it cannot be properly visualized through the cystoscope, or when it is concealed by the position of the ureterocele, and the point electrode cannot therefore be placed within the ureteral meatus, the electrode should be placed in the most prominent part of the pseudocyst, in order that thorough fulguration at that point may destroy the whole structure, which will then gradually slough off and permit adequate drainage.

B As a modern alternative to fulguration, in the same type of simple case, a *ureteromeatotomy* may be performed by the electric cutting current, the mouth of the ureteral orifice being cut away and the superfluous tissue removed either by means of minute cystoscopic scissors or by a knife electrode such as Kelly, Papin, Caulk, Bumpus, Collins, Moore, Riba, Beer and others, have devised for transurethral surgical work. This can be

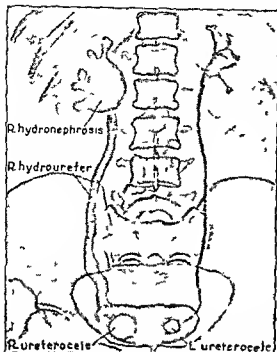


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The advantage of this new mode of attack is that it avoids opening the bladder and makes unnecessary the drainage of this viscus, which might materially prolong the post-operative care of the patient.

#### REPORT OF ILLUSTRATIVE CASES

From the series of 18 cases observed and treated by the author, the following 9 cases have been selected as typical illustrations of the findings, tending to confirm the conclusions which have been set forth in the preceding pages

**CASE 1** Simple unilateral ureterocele in a young female patient with frequency of urination, dysuria, urgency and bladder tenesmus, also complaining of indefinite abdominal and lumbar pain, diagnosed cystoscopically and relieved by cystoscopic fulguration of the ureterocele and further dilatations of the ureter with bougies and catheter drainage

Miss S F, 20 years of age, came to my office for examination in October, 1925, complaining of pain across the back, frequency of urination, and nocturia three to four times nightly, also bladder tenesmus and nervousness She had been receiving treatments from a local doctor without relief Cystoscopic examination revealed the presence of a left ureterocele about the size of a small olive During ejaculation the mouth of the left ureteral orifice was seen to be very small and of the pin-point type A No 4F catheter was difficult to pass, owing to the obstruction The right ureteral orifice was normal in all respects and could easily be catheterized with a No 6F catheter It was decided to fulgurate the mouth of the left ureteral orifice, in order to destroy the mucous membrane of the ureterocele Three weeks later both ureteral orifices were easily catheterized with a No 6 catheter without meeting obstruction The specimen collected from each side

was clear. Both kidneys were irrigated with acriflavine 1:1000 This treatment was carried out on several occasions until a bougie No 9 passed into each kidney pelvis without obstruction The cultures of the catheterized specimen were negative. The urinary symptoms cleared up and patient has been well ever since

**CASE 2** Unilateral ureterocele in a female patient complaining of acute cystitis, pyelitis, and pyelonephritis, with urographic evidence of hydro-ureter and hydronephrosis, successfully relieved by cystoscopic fulguration of the ureterocele, dilatations of the ureters and kidney pelvis lavage

Mrs K S, 34 years of age, was referred for persistent bladder symptoms by her husband in September, 1930 She had been suffering for 3 years with bladder tenesmus, dysuria, burning at urination, pyuria, and pain in right lumbar region radiating to the right lower quadrant She had been married for over 10 years and had no children Menstrual history was normal The voided specimen of urine was cloudy and contained pus Cystoscopic examination revealed the presence of a small ureterocele at the mouth of the right ureteral orifice, which admitted a No 4 catheter with some difficulty The left ureteral orifice was normal and admitted a No 6 catheter without obstruction The specimen collected from the right kidney was hazy, while that from the left kidney was clear. The phenolsulphonphthalein test showed that renal function was slightly diminished on the right side but was normal on the left The right pyelogram revealed a considerable degree of hydronephrosis with pyelitis and pyelonephritis, as well as dilatation of the ureter throughout its entire length The culture was positive for *Bacillus coli* and *streptococcus* infection The diagnosis was right ureterocele with hydronephrosis, pyelitis and pyelonephritis

Treatment was carried out cystoscopically with fulguration of the ureterocele, dilatation of the ureters, and kidney pelvis lavage with rivanol dextrose 1:2000 Patient was cystoscoped regularly at intervals of 2 and 4 weeks until a No 8 bougie passed repeatedly into the kidney pelvis without obstruction All symptoms cleared up and she is now enjoying good health

**CASE 3** Unilateral left ureterocele in a male patient who complained of pain across the lower back, slight frequency of urination and persistent microscopic pyuria and hematuria, causing his rejection by a life insurance company Cystoscopic examination revealed the presence of a left ureterocele about the size of an olive and the urographic studies showed a moderate degree of hydronephrosis with left pyeloureteritis, relieved by cystoscopic fulguration of the ureterocele, dilatation of ureters, and kidney pelvis lavage

Mr Ch C, married, 28 years of age, engineer, came to my office June 23, 1932, complaining of frequency of urination with dysuria, pain across back, and persistent microscopic pyuria and hematuria He had been operated upon for left varicocele



readily applied through an ordinary cystoscope or, preferably, through the panendo scope.

An inconvenient feature of this method is that it is not easy to control the exact amount of tissue cut away, and it is possible to excise too much of the wall of the intravesical ureter, carrying away a part of the muscularis fibers when, properly, in most instances only the mucosa should be cut. Moreover, the sphincter action of the new orifice may be unsatisfactory, and the procedure may result in regurgitation with vesicorenal reflux. Other ingenious devices for conservative transurethral treatment have also been presented for intravesical use, such, for instance, as various forms of snares devised by Burger, Foley, and others.

C Finally, there is the loop electrode method in use for endoscopic prostatic resection, which in some instances can be turned to good account for destroying and removing ureteroceles, just as it has been for removing a median prostatic lobe or solid tumors of the urinary bladder.

*Open surgical procedures.* It goes without saying that many unnecessary operations have been done for exposing and ascertaining the condition present within the bladder, in cases in which diagnosis has not been properly made before operation. In these modern urographic and cystographic days there is little reason to resort to cystostomy for diagnosis. Still there are vivid records in the literature of cases in which on the basis of a cystoscopic diagnosis of tumor of the bladder this viscus has been opened and a ureterocele discovered, which has been surgically removed by accomplishing a ureteroclectomy, followed by the placing of interrupted or continuous sutures around the mucosa of the ureter and bladder at the mouth of the ureteral orifice. Such a procedure has been reported with apparent success by Cohn Bazy, Pasteau, Albatran Fedoroff, Gayet Cathelin, Patch, Papin, and others.

Another type of open surgery of ureterocele has consisted in plastic repair of the ballooning portion, as in an ordinary hernia operation. Such a method was reported by Young in 1912, also with apparent success.

But a fact that must unflinchingly be kept in mind, in open surgical operations for ureteroceles, is that in advanced cases of this kind, a hydro-ureter and a hydronephrosis are almost certainly present, and in most cases these organs have become functionless. Partial measures directed to the removal of the ureterocele alone accomplish nothing where such conditions have arrived. When the cystoscopic findings reveal a large ureterocele and the pyelographic findings give evidence of an advanced stage of destruction in the upper urinary tract, the indications are given for a combined ureteronephrectomy or even a partial cystoureteronephrectomy, provided the condition is unilateral and there is assurance of a well functioning kidney on the opposite side. This operation, done in two stages, I described in 1931, in a paper on the indications for combined ureteronephrectomy, and I have emphasized the importance of ureterocele as one of the causes of hydro-ureter and hydronephrosis, in the third edition of Cabot's *Modern Urology*.

It appears therefore that, if this condition is discovered in early life it may be possible not only to treat it successfully by conservative measures, with dilatations of the ureter or fulguration of the ureterocele, but also to save the patient from further disease of the upper urinary tract, leading to acute conditions which may ultimately require radical surgery such as combined ureteronephrectomy.

In these advanced cases, in which kidney function has been lost through the obstructive effect of a ureterocele, and in which marked hydro ureter and hydronephrosis are present, the surgical procedure may be simplified by doing it in three stages. (1) The destruction cystoscopically of the ureterocele by simple fulguration, without opening the bladder. (2) If later on, the urographic studies reveal that the kidney and ureter are still hydro-nephrotic and functionless with urographic evidence of hydro ureter and hydronephrosis, the second procedure, or ureteronephrectomy, which I have described elsewhere and which is in itself a dual one to be done in one sitting, can then be instituted.<sup>1</sup> This will consist

first of ligation and section of the ureter at its base, close to the bladder, done either through the oblique incision running parallel to Poupart's ligament or through a median line or pararectus incision, not exceeding 5 to 6 centimeters in length, carried out extraperitoneally and retroperitoneally (3) After this the last stage, consisting of the removal of the kidney and attached ureter, in a single piece, is done through the usual lumbar incision When the kidney has a double pelvis and double ureters with evidence of hydro-ureter and hydronephrosis in only one-half of the organ, and the other ureter is functioning satisfactorily, a combined uretero-heminephrectomy may properly be carried out

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4 years before and had been cystoscoped elsewhere, but without diagnosis. Treatments for cystitis had given no relief. Cystoscopy now revealed the presence of a left ureteroceles with a much congested bladder mucosa and evidence of cystitis. Catheterization of the ureters was easily accomplished with two No. 5F catheters. Cultures of the catheterized specimens were negative. Phenolsulphonphthalein appeared in 4 minutes on the right side and in 4½ on the left with fairly good concentration of the dye. Ureteropyelograms disclosed the presence of a moderate degree of left hydronephrosis with marked pyelectasis and ureterectasis. He was treated cystoscopically with fulguration of the left ureteroceles and subsequent dilatations of the ureters and kidney pelvis lavage, together with administration of urinary antiseptics and forced fluids. Urinary symptoms gradually disappeared and a cystogram taken 3 months later showed a normal bladder with no evidence of vesico-ureteral reflux.

**CASE 4.** Ureteroceles complicated with an impacted stone at the mouth of the right ureteral orifice of a pin point meatus. Diagnosed cystoscopically in a patient with prostatitis seminal vesiculitis and multiple prostatic calculi. Relieved by endoscopic fulguration of the ureteroceles which made possible not only the delivery of the ureteral stone but the final correction of the ureteroceles.

Mr R F D aged 45 years married for 17 years no children. Patient was referred for examination on January 16 1934 complaining of hematuria pyuria and pain in right kidney region. He had suffered from arthritis for several years. He had been passing stones from childhood, with attacks of chills fever and pain the last stone having been passed in July 1933. He complained of frequency urgency nocturia dysuria and cloudy and foul urine. Rectal examination disclosed a moderately enlarged prostate of boggy consistency and with multiple calculi. Microscopic examination of the prostatic fluid revealed 40 per cent pus cells per field. The right kidney was enlarged and tender on palpation. Cystoscopic examination revealed the presence of right ureteroceles surrounded by bulbous edema and much congestion of the entire bladder mucosa. A small ureteral calculus could be seen lying at the mouth of the very minute right ureteral orifice and protruding from its lumen. The left ureteral orifice was normal. Right ureteral catheterization was impossible due to the impacted stone in the protruding ureteroceles. Roentgenographic examination disclosed the presence of the stone in the ureter and multiple stones in the prostate while intravenous urograms showed a slight degree of dilatation of the right kidney pelvis and ureter. The entire ureteroceles was fulgurated to allow the passing of the calculus which was afterward removed from the bladder by cystoscopic manipulations. Patient was apparently completely relieved of the acute symptoms caused by the obstructing ureteroceles.

**CASE 5.** Bilateral ureteroceles in male patient suffering from lumbago marked dysuria and frequency

of urination. Diagnosed by cystoscopic examination and cured by cystoscopic fulguration of the congenitally minute mouth of both ureteral orifices.

Mr D J S aged 43 years married suffering from persistent prostatitis and seminal vesiculitis for the last 10 years apparently following an attack of gonorrhea. He was examined in February 1933 at which time he complained of frequency dysuria hesitancy and persistent lumbago. He was operated upon for chronic appendicitis 7 years ago. The voided specimen of urine was clear, with shreds. Microscopic examination of the prostatic fluid revealed 20 per cent pus cells per field. Cystoscopy disclosed slight congestion of the entire bladder mucosa and two very minute ureteral orifices one on each side of the trigone. The ballooning of the ureteroceles which were about the size of lima beans could be observed during ejaculation. A No. 6F failed to pass and ureteral catheterization was accomplished with difficulty passing a No. 4F. Specimen collected from each kidney was clear and cultures negative. An electrode was placed at the mouth of each ureteral orifice and both ureteroceles were thoroughly fulgurated. The bladder was irrigated with silver nitrate 1:5000 twice a week and when patient was cystoscoped 3 weeks later both ureters appeared wide open and within normal limits. The lumbago and urinary symptoms disappeared and patient is cured at the present time.

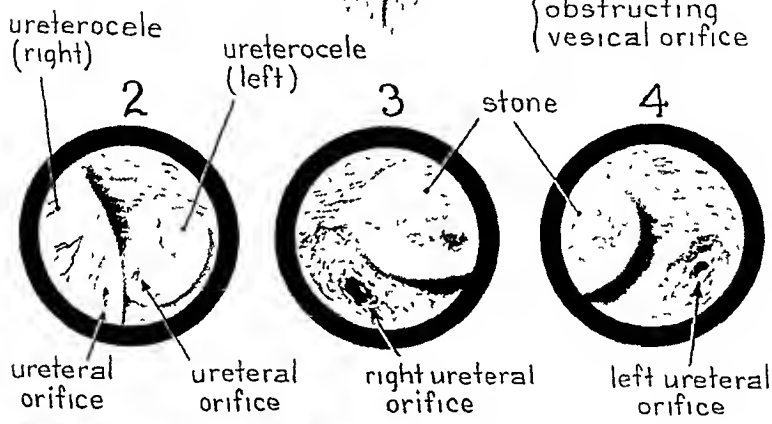
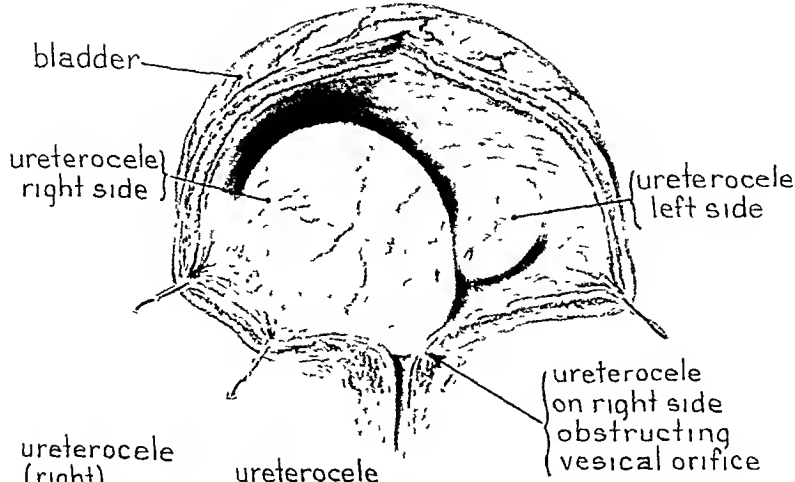
**CASE 6.** Bilateral ureteroceles in a female patient suffering with arthritis frequency of urination microscopic pyuria headaches nervousness and bladder tenesmus with evidence of marked cystoceles chronic cystitis pyelitis pyelonephritis nephropathy kinking of the ureters and hydro ureters and hydronephrosis successfully relieved by cystoscopic fulguration of the ureteroceles and kidney pelvis lavage.

Mrs J L 58 years of age housewife came to the office for examination on April 4 1936 suffering from arthritis and intermittent pain in both kidney regions sometimes radiating down along the course of the ureter to the bladder region and accompanied by frequency day and night dysuria and evidence

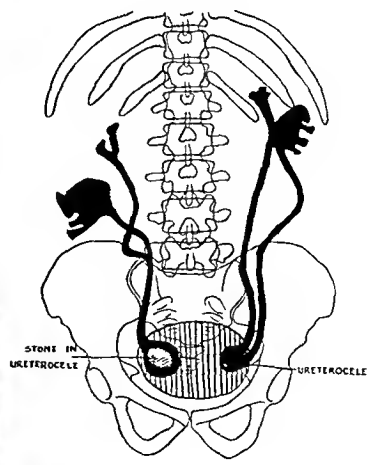
Fig. 9. Bilateral ureteroceles with a stone on one side causing complete retention of urine in a female patient with duplication of the ureters and kidney pelvis (Case 7). 1. Cystoscopic view of the bladder showing the actual size of the two ureteroceles producing mechanical obstruction at the vesical orifice. 2. Cystoscopic view showing the two congenitally narrow ureteral orifices during ejaculation. 3 and 4. Cystoscopic view of the right and left ureteral orifices 3 weeks after ureterostomy by fulguration showing the sloughing tissue around the newly opened ureteral orifices. The stone which was in the right ureteroceles and which was removed by cystoscopic manipulation can now be seen lying in the bladder after fulguration. 5. Bilateral pyelo-ureterogram made after the fulguration of the ureteroceles showing the duplication of the ureters and kidney pelvis on both sides. 6. Drawing from the bilateral pyelo-ureterogram showing graphically the concomitant anomalies which can be discovered only by routine urologic and urographic examination.

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Wm P Didusch  
1930



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Fig 9  
(Legend on opposite page)

of microscopic pyuria and hematuria. Had hysterectomy 15 years ago for fibroid tumor. On physical examination both kidneys were low and palpable and there was evidence of marked degree of cystocele. Cystoscopy disclosed much congestion of the bladder mucosa throughout. The meatus and both ureteral orifices were diminutive in size. The ballooning of the cystic dilatation of the intravesical portion of both ureters could be seen during ejaculation. Ureteral catheterization with No. 6F was difficult but two No. 4F passed easily and without obstruction to each kidney pelvis. Specimen collected from each kidney was hazy. Cultures revealed the presence of *Staphylococcus albus*. Phenolsulphonphthalein appeared with fairly good concentration in 3½ minutes from both kidneys. The retrograde pyelo ureterograms revealed the presence of bilateral hydronephrosis and hydro ureter with linking of the ureters, nephroptosis, and bilateral pyelitis and pyelonephritis. Patient was put on urinary antiseptics, forced fluids and kidney pelvis lavage. On the second visit both ureteroceles were cystoscopically fulgurated. Bladder irrigations and kidney pelvis lavages were continued in order to secure better drainage and relieve infection. Patient showed improvement 2 weeks after the fulguration of the ureteroceles. The urine cleared, cultures became negative and while she still suffers from a mild degree of cystitis due to cystocele she declares her general condition is much better and declines further operation.

**CASE 7.** Bilateral ureteroceles with stone in a female patient suffering from difficult micturition, bladder tenesmus and intermittent attacks of complete retention of urine in which urographic studies revealed the presence of a reduplication of kidney pelvis and ureters on both sides opening into two separate ballooning ureteroceles, one of which contained a stone about the size of a pigeon's egg. Diagnosed cystoscopically and relieved by cystoscopic fulguration and litholapaxy.

Mrs. M. G. aged 40 years, complained of intermittent attacks of retention of urine with dysuria, frequency and burning, dribbling and slight incontinence of urine, also of persistent lower abdominal pain for which she had been operated upon for chronic appendicitis without relief. Cystoscopic examination revealed two pedunculated mobile masses in the bladder. The one on the right side was so large that it covered the beak of the cystoscope and suggested a large tumor of the bladder, but careful inspection of the left ureteral orifice during ejaculation of urine disclosed the presence there of a small ureterocele. It was then discovered that the large pedunculated mass on the right side was a large ureterocele. Both ureteral orifices were of the pin point type and neither one could be catheterized. Both orifices were fulgurated through the cystoscope in an effort to destroy the ureteroceles and create new ureteral orifices. This was successfully accomplished and 3 weeks later cystoscopic examination showed a good sized stone in the fundus of the

bladder, which had come from the large ureterocele. The stone was crushed with a cystoscopic rongeur and completely removed by cystoscopic manipulations. At a later date both ureters were catheterized with ease and retrograde bilateral ureteropyelograms taken. These films showed a congenital malformation of the upper urinary tract with reduplication of ureters and renal pelvis on both sides with a slight degree of pyelitis, pyeloureteritis, hydronephrosis, linking of the ureters and right nephroptosis. Due to the presence of this infection a course of cystoscopic treatments was given with dilatation of the ureters and lavage of the renal pelvis. This promptly relieved the symptoms and there has been no recurrence up to the present time. Cystograms were taken which proved to be normal. There was no evidence of vesico uretero renal reflux.

This case illustrates the important rôle played by anomalies of ureters and kidneys in diseases and surgical conditions of the upper urinary tract, which can be cleared up only by proper urologic and surgical treatment.

**CASE 8.** Left blind ureter in an elderly female patient causing blind ureterocele with complete destruction and calcification of the corresponding left functionless kidney.

Mrs. M. B., 76 years of age, had been suffering from arthritis and complaining of chronic inflammation of the bladder for several years with a high degree of cystitis accompanied by dysuria and frequency of urination. The voided specimen of urine was hazy and microscopic examination of the sediment revealed 20 per cent white blood cells and red blood cells per field. On cystoscopic examination the left ureteral orifice could not be seen in the bladder. The right ureter was normal in location, shape, and position. In the area of the trigone where the left ureteral orifice was supposed to open a slight protrusion or cystic dilatation about the size of an olive could be seen which appeared to be a blind ureterocele. Attempts to catheterize this with all sorts of bougies and catheters failed repeatedly, while the right ureteral orifice was easily catheterized with a No. 6F Chromocysto tube. Urine was negative in that the administration of the blue dye intravenously showed a good elimination from the right kidney while it failed to reveal any from the left side. X-ray and intravenous urograms revealed the presence of a normal hypertrophic right kidney with good function and normal pelvis, but no excretion whatever of the dye from the left kidney in the three hour film. Although in the plain roentgenogram there was evidence of multiple calcifications in the area of the left kidney, surgical treatment was not carried out because of the patient's advanced age and the fact that she was comfortable with bladder irrigations and medical care.

**CASE 9.** Ureterocele arising from a diverticulum of the urinary bladder into which the minute ureteral orifice opened and which ballooned in and out of the

bladder during peristaltic ejaculations of the ureter or whenever the patient engaged in coughing or other similar muscular activities. Diagnosed cystoscopically and relieved by simple cystoscopic fulguration, subsequent dilatations of the ureter and kidney pelvis lavage.

Mr J W, aged 29 years, complained chiefly of frequency of urination, dysuria, pain in the suprapubic region, lumbago and cloudy urine, which persisted after an attack of gonorrhea. Urinalysis showed microscopic pyuria and hematuria. Rectal examination disclosed a moderate degree of prostatitis and seminal vesiculitis. Microscopic examination of the prostatic fluid revealed 20 per cent pus cells per field. No Neisser gonococci were found in the smear. The cultures were positive for *Bacillus coli*. Cystoscopy revealed slight hypertrophy of the trigone with marked elevation of the interureteric ridge and gradual disappearance of the left prominent angle of the trigone, where the opening of a diverticulum could be seen. During peristaltic contractions of the ureter or during ejaculation of urine or other abdominal contractions, the cyst-like formation could be observed ballooning in and out of the diverticulum (Fig 2). The ureteral orifice on the left side was so minute that it was rather difficult to catch the ureter during the brief moment of its appearance. It admitted a No 4F catheter only with great difficulty, while the right one was catheterized with a No 6F without obstruction. The minute mouth of the ureteral orifice was lightly fulgurated, inserting a small point electrode, after which the patient received a course of cystoscopic treatments with dilatations of the ureters and kidney pelvis lavage. His urine and symptoms cleared up satisfactorily. The conditions improved and he was discharged practically free of symptoms.

#### SUMMARY AND CONCLUSIONS

The modern concept of ureterocele, together with its diagnosis and surgical treatment, has been outlined.

A new anatomoclinicopathologic classification of the different stages and types of ureterocele has been presented.

The writer has had the opportunity to observe and treat 18 cases of ureterocele, 10 of which were in females and 8 in males.

Of this total, 5 cases were simple unilateral ureterocele; in 4 of these the condition was on the right side and in 1 on the left, showing the predominance of right sided ureterocele. Ten cases were simple bilateral ureteroceles, and included pseudocysts of all sizes, great and small; in all of these the characteristic ballooning and shining appearance of the sac of the ureterocele was demonstrated. Two cases had a stone in the ureterocele and here too the

condition was observed on the right side. There was one case of blind ureterocele in an elderly female patient suffering with arthritis and with radio-urographic evidence of complete calcification of the corresponding functionless kidney.

The condition of ureterocele can be discovered cystoscopically and visualized urographically in a good cystogram. The differential diagnosis from other lesions of the bladder is of importance, and it should always be made in a clear-cut way before operation.

Meatoscopy or careful cystoscopic examination of the ureteral orifices, regarding form, size, position, time of ejaculation and caliber of its lumen, is of great clinical and pathological importance, not only for establishing a proper diagnosis, but also for determining the prognosis of a given case.

Cystoscopic ureteral meatotomy, or opening of the intravesical ureteral orifice in these and similar cases, is of great value, not only because it allows better drainage from the kidney and ureter, but it also serves to prevent and correct the formation of ureterocele.

In this series of cases of ureterocele treated by simple cystoscopic fulguration, no complications have been encountered and the phenomenon of vesico-uretero-renal reflux has not been observed.

The occasional bilaterality, as well as the frequent concomitance of other anomalies, suggests the congenital nature of this malformation of the intravesical portion of the ureter. Certain other etiological forces, however, appear to play a contributory part in the progress of the disease. The paramount factors in the formation of ureterocele thus appear to be (1) the congenital narrowing of the intravesical portion of the ureter with a very minute meatus, (2) congenital weakness or absence of the longitudinal muscle fibers of the terminal portion of the ureter, resulting in abnormal mobility of the trigone, (3) loosening up of the vesical mucosa at the point where the ureter enters the bladder; (4) disturbances of dynamism and hydraulic pressure within the ureter, (5) lack of drainage due to obstruction in the lower ureter, and (6) presence of infection or other concomitant pathological lesions of the ureter and bladder.

In all the cases observed by the author, there was evidence of narrowing at the mouth of the ureteral orifice, causing obstruction, urinary stasis and pyelitis and pyelonephritis and in some of the cases there was urographic evidence of hydro ureter and hydronephrosis.

In one case of bilateral ureterocele, in a woman, the cyst on the right side which was a balloon shaped mass as large as a pear, contained a calculus the size of a pigeon's egg, it produced mechanical obstruction at the internal vesical orifice, resulting in intermittent attacks of complete retention of urine and sometimes dribbling and incontinence. In this case, which was successfully treated by cystoscopic fulguration and litholapaxy, pyelography at a later date revealed multiple anomalies of the upper urinary tract, exhibiting the presence of two kidneys and two ureters on each side in addition to the bilateral ureteroceles.

Another case of unilateral ureterocele was complicated by a small stone about the size of an olive pit, which, after cystoscopic manipulations, was passed without further surgical measures. This patient also showed evidence of multiple prostatic calculi.

Finally, an interesting case was observed of unilateral ureterocele which arose from a diverticulum in the urinary bladder at the left angle of the trigone, and which could

cystoscopically be seen ballooning in and out of the orifice of the diverticulum.

In all the cases of this series the patients were suffering with urinary symptoms, such as dysuria, frequency, urgency, incontinence, pyuria, hematuria, renal and ureteral colic, lumbar and lower abdominal pain, chronic uremia, and, in one case, even complete retention of urine. Nearly all had marked bladder symptoms with chronic pyelitis and pyelonephritis, and in 6 instances there was urographic evidence of marked hydro-ureter and hydronephrosis, which were apparently relieved by cystoscopic fulguration of the ureterocele, dilatations, and kidney pelvis lavage.

While ureteronephrectomy might have appeared to be indicated in some of these cases as in a case recently reported by Gibson, and as I have myself advocated for advanced cases, no true indication for this radical procedure was present in this series, since it was possible in all cases to restore the kidney function to normal and to overcome the urinary stasis and infection by the routine urologic treatment of cystoscopic fulguration with dilatations of the ureters and kidney pelvis lavage. Hence we may believe that in the majority of cases, when the diagnosis is made early, before irreparable disintegration of the kidney has occurred, minor transurethral surgical procedures will achieve permanent cure.

NOTE—Complete bibliography will appear in reprints of this article.

## ASEPTIC NECROSIS OF BONE

### II. Infarction of Bones of Undetermined Etiology Resulting in Encapsulated and Calcified Areas in Diaphyses and in Arthritis Deformans

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**N**O RECORD has been found in the literature of massive multiple infarcts of shafts and epiphyses of bones similar to those reported in Part I occurring in patients who give no history of having worked in compressed air. For that reason the following 3 cases are of particular interest.

**CASE 1.** T M, a 58 year old, single, white male, was admitted to the Veterans Administration Facility, Bath, New York, November 30, 1934. He had always worked at railroad construction except for a period of military service from 1917 to 1919. His complaints were weakness, shortness of breath, and swelling and stiffness of the left knee. He stated that 18 years previously he had a severe case of "inflammatory rheumatism" which confined him to bed for 6 weeks and he was told that the heart was involved. On admission to the Army in 1917, a heart murmur was present. He had an attack while in the Army with swelling of the left knee but remained on duty. There was a similar attack with the left knee in 1920. Following that he was more or less free until 2 years ago, and worked at railroad construction for a period of 8 years in Siberia and Central America. For 2 years the left knee has been continuously swollen and painful and he suffered from shortness of breath and occasional pain over the heart.

No other serious illness or accidents were reported. Venereal disease was denied. He drank alcohol in moderation but used no tobacco. On examination the well-nourished and developed individual, whose intelligence was above average, presented the following essential findings: Blood pressure, 170/100, some thickening of the peripheral arteries, slight cardiac enlargement with definite thrill and murmur of mitral stenosis, occasional extrasystole, no edema. The extremities were normal except the left knee which was markedly swollen and tender with an extension of the fluctuant swelling upward on the lateral aspect.

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of the thigh. No abnormal findings of the nervous system were noted. Laboratory examinations were limited to urinalysis and blood Wassermann, which were negative.

Roentgenological examination of the left knee region (Fig. 1) presented a sharply outlined, smooth, mottled, dense interior of the lower 11 centimeters of the shaft and the condyles of the femur. There was a dense narrow zone of demarcation about it and the cancellous bone peripherally located in the epiphysis and metaphysis was less dense than that of the interior. A similarly dense circumscribed central zone was present in the upper end of the shaft of the tibia. The cartilage space and articular cortex of the tibia were practically unchanged.

Roentgenograms were then made of the remaining skeleton, except the hands and feet. A similar central involvement was found in the lower end of the right femur (Fig. 2) and in both ends of the shaft of each tibia. Anteroposterior views of the tibias (Fig. 3) showed the lower limits of the central dense areas at the upper ends terminating hazily above the junction of the upper and middle thirds. The involvement at the upper limits of the shafts of the tibias is seen in Figures 2 and 3. The process was more sharply circumscribed at the lower ends terminating bluntly about 2 centimeters above the ankle joint on the right side and extending to the internal malleolus on the left side. There was a medullary shadow resembling a healed fracture near the middle of the left fibula. No abnormality was noted in the skull, either humerus, radius, ulna, the pelvis or upper ends of the femurs. The lumbar spine showed a hypertrophic spondylitis in its lower portion.

No appreciable change in the patient's condition occurred until April, 1936, when he expired 72 hours after a cerebral hemorrhage developed.

The essential necropsy findings were: cerebral hemorrhage, cardiac hypertrophy (580 grams), moderate sclerosis of coronary arteries with patent lumina, myocardium of normal appearance without scarring or fibrosis, chronic nephritis, no signs of infarcts in kidneys, spleen, liver, or intestines, a mild atheromatous change involving the intima of the aorta, much less than might be expected in view of the subject's age, the other larger vessels were essentially normal, adrenals and thyroid normal, parathyroid tumor searched for but not found. Microscopic examination of the myocardium, lungs, liver, spleen,





Fig 1. Case 2. Walled off dense areas in lower third of femur and in upper diaphysis of tibia.

hypophysis thyroid prostate and kidneys gave little evidence of old or recent damage to parenchyma and nowhere did the arteries show changes of unusual type suggestive of healed or active rheumatic fever or polyarteritis nodosa.

**Skeletal system.** There was a moderate hypertrophic spondylitis most marked about the upper dorsal vertebrae. A most interesting lesion of the left knee prevailed. It was swollen and fluctuant the swelling extending about one third the way up the lateral aspect of the thigh. Incision disclosed a large multilocular cyst like projection of the synovial membrane (Baker's cyst) filled with fairly clear yellowish odorless synovial fluid of a syrupy consistency. The lining membrane which averaged 3 millimeters in thickness presented especially in the joint capsule proper innumerable villi averaging 1 centimeter in length yellow pedunculated soft and homogeneous in consistency (Fig 4). There was slight synovial overgrowth of the margins of the articular cartilage with destruction of cartilage in some places. In others the cartilage showed flat nodular hypertrophy.

Microscopic sections of the villi showed them to consist of an interior of vascularized loose connective tissue and fat with a thickened synovial covering and many large to small subsynovial areas of round cell infiltration. The picture was like that commonly seen in chronic proliferative arthritis.

The distal 16 centimeters of the femur was removed. Roentgenograms of the specimen (Fig 5) showed no perceptible changes over those revealed in Figure 1 representing the condition on admission 15 months previously. Coronal sections through the



Fig 2. left. Case 1. Right knee changes similar to those in left.

Fig 3. Case 1. Lesions at ends of diaphyses of tibia similar to those in femur.

bone (Fig 6) disclosed a shaft and condyles of normal diameter. The periosteum was normal in appearance and a viable looking cortex was present which in the region of the shaft consisted of a thin dense outer portion and a less dense lamellated inner portion. Adjacent to the cortex and in the bulk of the epiphysis was viable spongy bone but the central portion of the diaphysis was occupied by a mottled yellowish to dark gray lusterless tissue which extended downward into the central portion of the mesial condyle in this plane and into the lateral condyle in a more posterior plane. Its lower part contained cancellous bone which faded out in the upper portion. This central area was surrounded by a narrow dense dark zone which sharply demarcated it from the cancellous bone externally and from the medullary cavity at the upper limit of the specimen. Microscopic preparations were made of transverse sections of the upper end of the anterior half.

A longitudinal section cut from the remaining portion was roentgenographed (Fig 7), decalcified, sectioned in celloidin and stained with hematoxylin and eosin (Fig 8). Microscopic examination showed that all of the bone of the central area within the zone of demarcation was dead. Its trabeculae were of normal size and arrangement but its lacunae were totally devoid of cells.

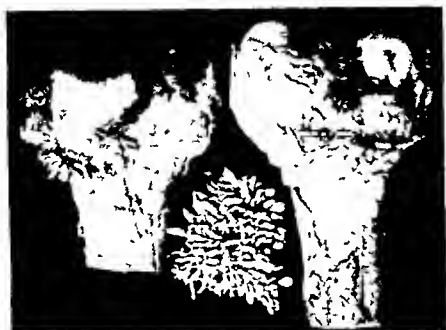


Fig 4 Case 1 Front and back views of sectioned femur and of villous synovia

Its cancellous spaces were filled very largely with necrotic fatty marrow which had retained to a remarkable degree the contour of the fat cells (Fig 9). In about half its extent and especially centrally the fat spaces were discrete and clear as if still occupied by fat, but the condition was apparently an edema *ex vacuo*. In most of the remaining portion and especially toward the periphery the cell outlines were more or less confluent and occupied by a granular debris or coagulum, stained faintly with eosin. The narrow zone of demarcation (Fig 10) consisted of fibrous tissue filling the cancellous spaces, much of which had undergone very extensive calcification and to a less extent ossification. The calcification was seen to be progressive, especially internally. In some regions a very acellular fibrous tissue extended inward from it, usually for a short distance replacing the dead marrow. Along the mesial side above the middle the fibrous invasion of the dead area was extensive (Fig 6) and at its lower limit there was a transverse streak of calcification extending into it (Figs 7 and 8). All around the periphery of the dead area was more or less extensive granular calcification of the necrotic marrow. This calcification of its limiting wall was mainly responsible for the greater



Fig 5 Case 1 Roentgenogram of excised end of left femur. Like Figure 1, taken 16 months before

density of the shadow of the necrotic area in the roentgenograms. The bone and marrow outside the zone of demarcation were alive with the exception of portions of a few trabeculae along its surface which were dead and in process of replacement by living bone. In the zone of demarcation itself there was also some old dead bone which showed sluggish signs of creeping substitution by new bone (Fig 11). The live bone of the diaphysis surrounding the dead area measured 6 to 12 millimeters and was streaked by wavy longitudinal trabeculae. The cortex increased to normal thickness at the upper limit of the lesion. The trabeculae of the spongy bone of the epiphysis were less dense than those of the dead area above, which suggested that the dead area was originally larger and had been partly replaced by new bone. The periosteum was essentially normal in appearance. It contained a moderate number of arteries and arterioles. An occasional artery showed arteriosclerosis with calcification. No sign of thrombosis or embolism was discernible in or about the necrotic area.

At the articular margins of both condyles there were small osteophytes and villous synovia showing round cell infiltration. The articular cartilage as

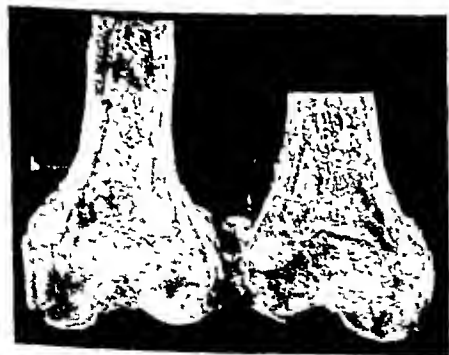


Fig 6 Case 1 Central infarct with zone of demarcation, b



Fig 7, left Case 1 Roentgenogram of slice showing zone, a, demarcating infarct

Fig 8 Case 1 Microscopic section of slice showing infarct demarcated by dense zone, a



Fig. 9. Case 1. Periphery of infarct showing central necrotic bone *a* zone of demarcation *b* and surrounding living bone *c*.

seen in Figures 4, 6 and 8 was somewhat unequal in thickness and at the mesial and lateral margins it had been replaced by fibrocartilage which was continuous over the marginal spurs. There was a variable amount of proliferation, degeneration, fibrillation and cavitation in the more superficial portions of the rest of the cartilage.

The lesion of the femur was a massive infarct of the interior of long standing which had been partly replaced by new bone about its periphery but replacement had practically come to a standstill and the fibrous zone of replacement had calcified and ossified. Since there were no signs of sequestration or of inflammation present it must be concluded that the necrotic area had not been infected. And although there was no pathological examination of the lesions of the other bones the similarity in roentgenographic appearance leaves no doubt that they were of the same nature and that the condition was that of multiple massive infarction of bone. Since the nature of the condition was not recognized during life there was no special inquiry for etiological factors as work



Fig. 10. Case 1. Central necrotic bone. Trabeculae not etiolated. Outline of dead fat cells preserved in some places *a* but lost in others *b*.

in caissons or old injury that might have produced symmetrical fat embolism of the bones.

CASE 7. J. J. white male aged 45 years occupation automobile mechanic entered the United States Veterans Administration Facility Dayton Ohio January 22 1935 complaining of pain and stiffness in hip knees and shoulders and swelling of the feet and ankles. He was in military service in 1918-19 and a month after discharge in 1919 developed a limp in the left hip. Although the difficulty progressed it was possible for him to work as an automobile mechanic fairly steadily until 1926. He then developed pain in the right hip and ankle region with swelling of the ankles and had to give up work. Aching pains also appeared in the shoulders more marked in the left. He could recall no injury to any joints. The pain and stiffness in the involved joints had slowly increased since then and he had been unable to work. Several teeth had been extracted because his condition was thought to be due to focal infection. In 1934 he had a sudden attack of dizziness and fell out of a chair. He had remained in general good health.

**Past history.** He was unusually healthy as a child and had no childhood diseases no history of rheumatism. His first work was in a machine shop and after that he served continuously as an automobile mechanic except for military service. He did not have worked in a caisson or under increased air pressure in any form.

**Family history.** Father died of an injury at the age of 74 mother at the age of 76 cause unknown. Four brothers and 1 sister were living and in good general health. One sister died of a tumor at the age of 45 years 1 brother of a stroke at the age of 57 years. The patient knew of no illnesses similar to his in the family.

**Physical examination** showed a well developed adult man who walked poorly with the aid of a cane because of pain and stiffness in the lower extremities. The only abnormal physical findings aside from the extremities were perforation of the left ear



Fig. 11. Case 1. Zone of demarcation showing old dead bone *a* calcified fibrous tissue *b* and living replacement bone *c*.



Fig 12 Case 2 Increased density in humeral head

drum with hearing—left, 15/20, right, 20/20, and several missing teeth. Blood pressure was 160/110. Urinalysis was negative, no Bence-Jones protein. Red blood cells numbered 4,400,000, hemoglobin was 85 per cent, white blood cells, 11,000, no abnormal cells, Wassermann and Kahn tests were negative.

**Extremities** The upper extremities were free aside from slight limitation in the shoulders, more marked in the left. The lower extremities showed brawny swelling below the calves of the legs. The hips showed marked limitation of abduction and rotation with flexion to almost 90 degrees. No limitation of motion and no tenderness in knees and ankles were revealed, no outwardly visible varicose veins.

Roentgenograms were made of the entire skeleton. The head of the left humerus contained a large irregular oval subcortical area of markedly increased density and there was slight lipping of the inferior margin of its articular surface (Fig 12). The upper metaphysis of the right humerus contained a few, small, scattered areas of increased density, without any changes in the shoulder joint. A roentgenogram of the pelvis showed extensive changes in the hip joints, especially in the heads of the femurs (Fig 13).



Fig 13 Case 2 Old transformed necrotic areas in heads of femurs with secondary deforming arthritis in hip joints



Fig 14, left Case 2 Remnants of old necrotic areas in ends of left tibial shaft casting heavy calcium shadows

Fig 15 Case 2 Remnant of old necrotic area in upper end of right tibial shaft partly replaced by new bone and partly calcified. Mottled central trabeculae at lower end possibly indicate previous necrosis completely replaced by new bone

The left hip, which had produced symptoms longer, showed flattening of the head of the femur, marked narrowing of the cartilage space of the joint, and marginal lipping. There was a large area of increased density in the head underlying the fovea and extending into the proximal portion of the neck. It was irregularly lamellated near the fovea. Opposite the superior and lateral portion of the head there was an oval subchondral area of reduced density in the acetabulum. The right hip showed little reduction in



Fig 16 Case 2 Areas of increased density in internal and external supracondylar regions and posterior portion of external condyle right femur. Calcified remnants of old necrotic bone



Fig 17 Case 2 Roentgenograms showing areas of increased density in the internal and external supracondylar regions left femur

cartilage space and moderate marginal lipping. At the top of the head there were shadows of two depressed fragmented dense areas consisting of articular cortex and underlying bone which were separated from the remaining head by a zone of reduced density. The surrounding bone extending into the proximal portion of the neck was irregularly increased in density. At the superior lateral margin of the acetabulum there was a large oblong area of reduced density with a surrounding zone of increased density.

The roentgenological findings indicated that there had been extensive necrosis in the heads of the femurs with subsequent breaking down or bony replacement or calcification of the necrotic regions. Two aseptic sequestra had been separated by weight bearing at the top of the head of the right femur and a cavity had formed at the superior and lateral margin of either ilium.

The left tibia revealed a blotchy oblong area of markedly increased density in either end of the shaft as shown in Figure 14. The fibula showed no change. There was a lesion in the upper third of the shaft of the right tibia similar in nature roentgenologically but slightly smaller than that in the left tibia (Fig 15). The lower end of the right tibia showed slight irregularity of trabeculae as if a similar lesion may have existed which had been completely absorbed and replaced by new bone. The lower end of the shaft of the right femur showed 2 central areas of increased density, the larger in the external supracondylar region and the smaller in the internal supracondylar region. The posterior portion of the external condyle also showed an oval area of increased density. The supracondylar region of the right femur showed 2 centrally situated oval areas of increased density, the larger one being lateral and the smaller

medial. The posterior part of the external condyle also contained an oval area of increased density (Fig 16). The supracondylar region of left femur contained 2 irregular oblong areas of increased density, one medial and the other lateral, much larger than those on the right side (Fig 17). The bones and joints of the rest of the skeleton showed no changes except a slight narrowing and bony bridging of the tenth thoracic intervertebral space.

The patient remained for 3½ years in the Facility with but slight increase in his symptoms, and roentgenograms taken at the end of that period showed very little change in the picture.

The diagnosis was made of old multiple aseptic necrosis of epiphyses and diaphyses of long bones of the extremities with secondary arthritis deformans and partial bony replacement and partial calcification of the necrotic areas.

CASE 3. C. W. aged 43 years entered the U. S. Veterans Administration Facility Bath, New York July 22, 1938 complaining of pain in the extremities, most marked in the legs. For about 9 months he had had aching pains and a feeling of stiffness in the lower extremities from the hips downward. There had also been neuralgic pains in the upper extremities but apparently much less severe. At no time had he been laid up because of the complaint and he was able to get around with ease.

Past history revealed the usual diseases of childhood, fractures of both bones of both legs at 15 years followed by healing and complete return of function, gunshot wound of left thigh region and right Colles fracture during World War. No other illnesses or injuries were mentioned.

Previous to World War service patient worked as a railroad brakeman and since then as a laborer.



Fig 18 Case 3 Views of right tibia



Fig 19 Case 3 Left tibia

about mines. He had never worked underground or under compressed air and had never had rheumatic fever.

He used alcohol to excess periodically, smoked about 10 cigarettes daily.

Venereal disease denied. No hereditary diseases in the family.

Physical examination revealed a fairly well developed and well nourished man who was ambulant and active and not acutely ill, weight 140 pounds. Blood pressure was 130/84. Regional examination of head, neck, thorax, abdomen, and genito-urinary tracts was essentially negative. A soft mass was present over the back of the right olecranon process. There was no limitation of motion in any joints and no tenderness on palpation of the joints or of the brachial plexus or sciatic regions. The pupils reacted to light and accommodation and the reflexes in the extremities were normal. No disturbance of sensation was elicited. Wassermann and Kahn reactions were negative. Urine and blood examinations revealed essentially normal findings.

Roentgenograms were made of shoulders, chest, lumbar spine and pelvis, shafts of both femurs, tibias and fibulas, and of the right elbow and wrist. They revealed normal bone and joint shadows aside from the shoulders and shafts of tibias and femurs. Shadows of bony calluses were noted at the seats of the fractures in both fibulas and the right tibia. Blotchy areas of increased density were evident in the upper thirds of the tibias as shown in Figures 18 and 19. Similar regions about 2 inches in length were noted in the lower third of the shaft of each femur (Fig 20). Degenerative changes as shown in each shoulder joint also were noted. The rest of the skeleton and the thoracic viscera cast normal roentgenological shadows.

In view of the history and the similarity of shadows of increased density in this and the preceding

cases, a diagnosis was made of old aseptic necrosis of relatively small areas of the interior of the bones with organization by irregular calcification and ossification. No other explanation was found for the stiffness and pains in the extremities. Also there was nothing in the history to which the lesions might definitely be attributed. Judging by the other cases the lesions were of much longer standing than indicated by the history of pains in the limbs over a period of 9 months. However, the patient was unobserving and may have given an incorrect anamnesis.

In view of the great similarity of roentgenological and pathological findings in the first 3 cases and in the 4 cases reported in Part I, the condition might readily be explained on



Fig 20 Case 3 Blotchy increased density in lateral portion of lower diaphysis of each femur

the basis of aseptic necrosis of the bones produced by caisson disease.

In Case 1, which was the first to be examined at autopsy, there was no history of work in caissons but since caisson disease was not suspected during life, no inquiry was made about it. In view of his occupation as a railroad construction worker, there is a bare possibility that the attack of "rheumatism" 18 years before admission was due to caisson disease. In Cases 2 and 3, on repeated inquiry and after stressing the possible etiological relationship no history of work in caissons could be elicited. Unrecognized fat embolism is a possibility to be considered. Case 3 had a severe injury with fractures of both bones of both legs at 18 years and of a gunshot fracture of the left ilium and a Colles' fracture of the right radius at 23 years. Case 1 showed in roentgenograms of the left fibula a transverse shadow like that produced by an old fracture but there were no roentgenographic signs of old fractures in Case 2. No report was found of bone infarction produced by fat embolism but should it occur the lesions might well be as symmetrically distributed as those resulting from nitrogen gas in caisson disease.

That the cause of the necrosis was an agent which interrupted the blood supply without leading to infection of the involved area is indicated by failure of sequestration of the dead bone and by the resemblance of the invasion and creeping replacement of the dead bone to that seen in caisson disease and that reported by Axhausen (1 bib.) Phemister (11, 12), Schmorl, Santos, Gastreich and others in the necrotic head of the femur resulting from intracapsular fracture of the neck. There was a difference in that the fractures were of shorter duration and there was rarely calcification in the zone of fibrous invasion and replacement by new bone.

If the lesions were the result of simple obstruction of arteries, what vessels were involved? In case of the heads of the femurs and left humerus and the external condyle of the right femur the epiphyseal vessels could be blocked as their branches in adults may be end arteries especially in the case of the head of the femur. The lesions in the diaphyses of the tibiae of Case 1 and of tibiae, fibulae and

femurs in Case 2 were in the distribution of the nutrient arteries supplying the ends of the shaft. But the lower epiphyses of the femurs were involved along with the diaphyses in Case 1. Assuming that blockage of the nutrient artery would cause necrosis of the interior of the lower end of shaft of femur, it would be necessary that there be a reorganization of blood supply of the epiphyses after closure of the epiphyseal line in order to have it involved in a system of end arteries with the shaft. While the experimental evidence is somewhat averse to this theory, there are limited but concrete necropsy observations of anemic infarcts in adults involving both ends of shaft and epiphyses.

Kistler blocked aseptically the nutrient arteries of the femur of the rabbit by the injection of finely powdered charcoal which filled the vessels to their finer terminals. When epiphyseal lines were open there resulted necrosis of medullary contents of diaphysis extending sometimes to the epiphyseal cartilage plates and also of the inner one half to two thirds of the cortex. In adult dogs where the lines were closed there was more limited necrosis confined to the medulla away from the ends. Simple ligation or division of the nutrient artery resulted in either much less or no necrosis. This would suggest that obstruction followed by thrombosis extending distally to the terminal branches would be most likely to cause necrosis.

Other evidence that obstruction of the main nutrient vessel at one point would not produce massive infarction is the fact that it does not follow fracture of the shaft of a long bone with severance of the nutrient artery. It is extremely rare that roentgenographic changes are observed after fracture of the shaft of a long bone which give the appearance that necrosis of a fragment has followed as in the case reported by Ransohoff where marked irregular absorption of distal diaphysis suggesting necrosis resulted from fracture just above the middle. But 15 months later it had largely disappeared and 11 years later the roentgenographic appearance was normal showing that if necrosis did occur it was completely repaired and that medullary calcification was not a sequel. Injection studies by

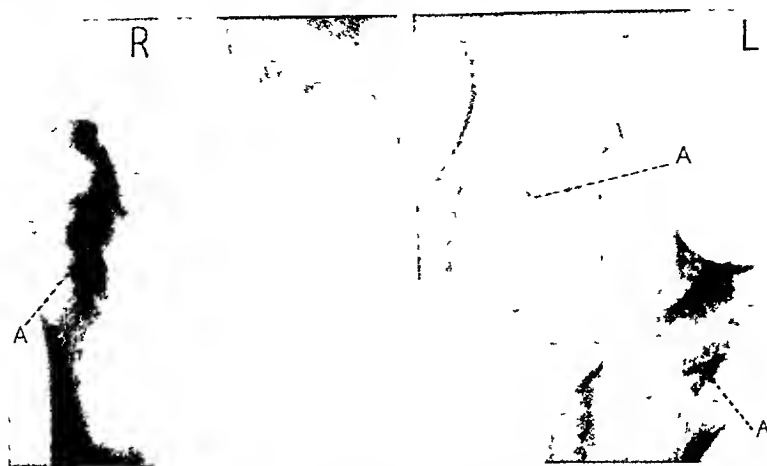


Fig 21 Case 4 Slipped left capital femoral epiphysis with dense areas in weight bearing portion of head and in the metaphyses beneath the greater trochanters interpreted as necrotic lesions, A

Nussbaum, Lexer and others, have shown that during childhood small end arteries enter from the periphery and supply parts of the metaphysis. According to Nussbaum the epiphyseal arteries in childhood are not end arteries. That after closure of the epiphyseal lines end arteries may come into existence which overlap the end of the shaft and the epiphysis is shown by the following classical case of multiple anemic infarction reported by Axhausen.

A 46 year old laborer who died of cirrhosis of the liver had a large infarct in the upper metaphysis of the right tibia and three infarcts of the right femur, one of which involved the head and a part of the neck, one the lower metaphysis and a small portion of epiphysis, and one the mesial condyle bordering on the articular cartilage. They were all relatively recent infarcts with a zone of fibrous tissue in the marrow immediately surrounding the necrotic area in which there was beginning absorption of the dead bone and replacement by newly formed bone. Microscopically there was no sign of infection although *Streptococcus brevis anhemolyticus* grew on cultures of the infarcts. Axhausen considered them due to vascular blockage by emboli which contained the streptococci that were too avirulent to set up infection in the infarcted fields. It should be noted, however, that no emboli were seen in microscopic sections of the infarcts, neither were vegetations noted on heart valves nor mural thrombi on the walls of left heart or aorta.

Axhausen maintained that this case supports the variously advocated view that Legg-Perthes' disease, Osgood-Schlatter's disease,

Koehler's diseases of the tarsal, navicular and metatarsal bones, Kienbock's malacia, and osteochondritis dissecans are anemic infarcts of the epiphyses or short bones. He thought that some are due in part and others exclusively to bland embolism. Freund, Chandler, and others have reported large areas of aseptic necrosis in the head of the femur, sometimes bilateral, arising in adults without known cause. Multiple necrosing lesions of the epiphyses and to a lesser extent of the metaphyses of unknown etiology occurring during adolescence have been reported by Harbin. The metaphysis may be involved without the co-existence of necrosis of its epiphysis as in the following case under the care of Dr. Compere.

CASE 4 A 13 year old girl had slipped epiphysis of the head of the left femur, producing symptoms for 1½ years. A roentgenogram (Fig 21) showed downward displacement of the head of the left femur and flattening and greater density of its weight bearing portion indicative of necrosis. Oblong areas of increased density in the metaphyses were also present beneath the greater trochanters, which were interpreted as having undergone aseptic necrosis and as being in the process of organization. A roentgenogram 16 months later showed that the dense shadows in the left head and subtrochanteric region had disappeared and there was great reduction in density of the shadow in the right subtrochanteric region.

It is conceivable that this same process may occur in adults and affect nutrient arteries as well as metaphyseal and epiphyseal arteries.



As to the disease process which blocked the arteries in the first 3 cases there is even greater uncertainty than as to the exact vessels that were blocked. Embolism and polyarteritis with or without associated thrombosis are the two conditions to be considered. In Case 1 it is fair to assume that the infarction dates from the occurrence of the attack of "rheumatism" 19 years before as judged from the history and the pathology. If the so called rheumatism were rheumatic fever, could it have produced either embolism or polyarteritis in the bones with the resultant infarction?

The old mitral and aortic stenosis may have resulted from rheumatic endocarditis but the vegetations in rheumatic valvular disease are small and firm and are not definitely known to give rise to emboli with resultant anemic infarction. Secondary infection in rheumatic valvular disease by *Streptococcus viridans* gives the picture of subacute bacterial endocarditis often with visceral infarction and a fatal termination in a very high percentage of cases. But no reports were found in the literature of bone infarcts in subacute bacterial endocarditis, although there is little evidence that an extensive systematic search for them has ever been made. A strong point against embolism from thrombi or vegetations in this case is the absence of old infarcts in the other organs containing end arteries. Also the mathematical probability that embolism aside from gas or fat embolism would produce such symmetrical lesions is so small as practically to rule it out.

Arteritis is known to occur in various infectious diseases as shown by the recent review of the literature by Karsner and Bayless. In a complicated case of scarlet fever reported by Hoyne there was symmetrical gangrene of the hands, feet, cheeks, and ears. Rheumatic fever commonly produces coronary arteritis as shown by the reports of Von Glahn and Pappenheimer, Karsner and Bayless and others, and sometimes it results in occlusion with or without thrombosis and severe myocardial damage. The peripheral arteries however are much less frequently involved. Von Glahn and Pappenheimer found specific rheumatic lesions of the arteries of the lungs, kidneys, perirenal and periadrenal connective tissues

and testes in 10 of 47 autopsied cases of rheumatic carditis. They consisted of isolated swelling of the endothelium, necrosis of muscle and elastica, fibrinous exudation and cellular infiltration about the periphery. Necrotizing arteries may occur in the aorta and Neale and Whitford reported 2 cases which resulted in rupture of the aorta and death. No report was found of arteritis of the skeletal or any other extremity arteries in rheumatic fever. This fact and the absence of a history of acute arthritis in Case 2 makes it impossible to conclude that rheumatic fever or arteritis was the causative factor in either reported case.

Periarteritis nodosa with or without associated rheumatism produces markedly obstructive lesions which if situated in the bones, might well result in infarction, but the fact that this patient survived the initial attack for 19 years practically excludes it from consideration since periarteritis nodosa is a fatal disease. Arterial spasm as in Reynaud's disease or thrombo angustis obliterans are highly improbable factors.

Small septic emboli, which are the initial stage of perhaps most cases of pyogenic osteomyelitis, result in infarcts in the ends of the shafts of the bones of children. Large septic emboli have been held by Axhausen and Winkelbauer to account for the cases of osteomyelitis with very extensive bone necrosis and little associated pus. However, in these septic cases the area of dead bone is soon more or less absorbed and sequestered and the surrounding bone invaded by the inflammatory process so that the infarct soon becomes unrecognizable. If early death occurs the infarcts may be seen. The case of von Volkmann reported in 1864 was of this kind.

A 12 year old boy died of acute vegetative endocarditis which produced a septic picture with pain, swelling and abscess in the left ankle region. Autopsy disclosed 3 hemorrhagic infarcts of the calcaneus and infarction of the entire talus with surrounding abscess formation. Two large and 9 small infarcts were seen in the lower portion of the left tibia, some of them being in the epiphyses. Also a large infarct was present in the proximal one third of the right ulna. Vegetations on the mitral valves and embolism had resulted in septic infarcts with pus in lung, brain, kidneys and small intestine. As would be expected there was a complete lack of symmetry in the distribution of the infarcts.

The chronic arthritis of the left knee in Case 1 and of hips and shoulders in Case 2 may be explained as in caisson disease on the theory advocated by Axhausen, Wollenberg, and others of primary aseptic necrosis of bone bordering on the articular cartilage of the joint as a result of blockage of its blood supply. Necrosis at the knee may have reached the articular surface in some place at the onset in which case the cartilage suffered necrosis followed by arthritic changes and the synovia became secondarily involved. The case reported by Hirsch and Ryerson of massive aseptic necrosis of a femoral condyle had an associated chronic arthritis. Also fracture of the neck of the femur followed by death of the head and bony union results in late arthritis even when the head becomes replaced by new bone without any collapse as observed by one of us (D B P) in 2 cases.

#### SUMMARY

A case of symmetrical massive infarcts of bones and chronic arthritis of the knee is reported which came to autopsy and which presented roentgenological and pathological findings of the same character as those reported in caisson disease and published in Part I of this series. Two other cases are reported which presented similar roentgenological findings. In no case was there a history of work in caissons. In Case 1 there was a history of a severe attack of "rheumatism" at the onset. Rheumatic fever producing embolism or peripheral arterial disease and other forms of arteritis obstructing intra-osseous vessels were considered but no proof was found at autopsy that any known disease producing vascular lesions was the cause of the infarction. In the 2 other cases there was no history of disease previous to the onset of the extremity and joint pains which initiated the clinical manifestations. Undiagnosed fat em-

bolism was considered because of the symmetrical distribution of the lesions and of the history of ancient multiple fractures in Case 3 and radiographic signs of ancient fracture in Case 1. The cases are discussed in relation to published reports of idiopathic necrosing lesions of the epiphyses and metaphyses seen not infrequently in late childhood and adolescence, and rarely in adult life. They demonstrate the rôle that vascular blockage followed by aseptic necrosis of bone bordering on joints may play in the causation of certain forms of chronic deforming arthritis.

#### BIBLIOGRAPHY

- 1 AXHAUSSEN Ueber anaemische Infarkte am Knochen-system Arch f klin Chir, 1928, 151 72
- 2 CHANDLER, F A Aseptic necrosis of the head of the femur Wisconsin State M J, 1936, p 1
- 3 FREUND, E Zur Frage der aseptischen Nekrose Arch f path Anat, 1926, 261 141
- 4 HARBIN, M, and ZOLLINGER, R Osteochondritis of growth centers Surg, Gynec & Obst, 1930, 57 145
- 5 HIRSCH, E, and RYERSON, E W Necrosis of the distal epiphysis of the right femur J Am M Ass, 1929, 93 679
- 6 HOYNE, ARCHIBALD L Raynaud's disease, report of a case of symmetrical gangrene of unusual severity J Am M Ass, 1915, 65 1725
- 7 KARSNER, H T, and BAYLESS, F Coronary arteries in rheumatic fever Am Heart J, 1934, 9 557
- 8 KISTLER Sequences of experimental infarction of femur in rabbits J Bone & Joint Surg, 1934, 29 589
- 9 LEXER, E Weitere Untersuchungen ueber Knochen-arterien und ihre Bedeutung fuer Krankhaften Vorgaenge Deutsche Ztschr f Chir, 1904, 43 481
- 10 NUSSBAUM, A Die arteriellen Gefaesse der Epiphysen des Oberschenkels und ihre Beziehungen zu normalen und pathologischen Vorgaenge Beitr. z klin Chir, 1923-1924, 130 495
- 11 PHEMISTER, DALLAS B Aseptische Knochennekrose bei Frakturen, Transplantationen und Gefass Verschlussen Ztschr f orthop Chir, 1931, 55 161
- 12 Idem Bone growth and repair Ann Surg, 1935, 102 261
- 13 RANSOHOFF, N S Osteoporosis of the humerus following fracture Ann Surg, 1929, April, 571
- 14 VOLKMAN, R VON Embolische Knochennekrose nach Endocarditis Arch f klin Chir, 1864, 5 330
- 15 VON GLAHN, W C, and PAPPENHEIMER, A M Specific lesions of peripheral blood vessels in rheumatism Am J Path, 1926, 2 235

# THE DIAGONAL CONJUGATE VERSUS X-RAY PELVIMETRY

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**A**LTHOUGH the external conjugate or Baudelocque diameter of the pelvis is still widely employed in obstetric mensuration, there is ample evidence to show that this measurement is totally unreliable as a gauge of the true pelvic inlet. When Baudelocque recommended the measurement some 120 years ago he believed that this diameter was in the same plane as that of the conjugata vera and, as it were, represented simply a linear extension of the conjugata vera anteriorly through the symphysis pubis and posteriorly through the sacrum. Accordingly in order to estimate the conjugata vera, he advised that a figure representing the thickness of the pubis plus that of the sacrum be subtracted from the external conjugate. On the basis of measuring 33 pelves at autopsy he stated that the figure to be subtracted was 8 centimeters ('trois pouces, 8 1/2 centimeters'). So certain was Baudelocque that the thickness of the sacrum and pubis was constant that he claimed an accuracy in estimating the conjugata vera of  $\pm 2$  millimeters ( $\pm$  "une ligne," 2.5 millimeters).

It has been known for many years that the obstetrical conjugate and external conjugate are not in the same plane as may be seen in Figure 1, in many pelves the angle between the two diameters is even greater than is shown here. This fact alone annuls the theoretical basis of Baudelocque's conception. More important is the fact that the thickness of the sacrum and pubis is not constant but shows the greatest variation. As a result of these two sources of error, the amount to be subtracted from the external conjugate to give the conjugata vera is not constantly 8 centimeters but as shown by Dohrn, von Schubert, Skutsch, Thoms, Schumann and Yamabe ranges from 3.9 to 13.0 centimeters.

In a study of 115 pelves some normal and some abnormal, we have found that the dif-

ference between the external conjugate or Baudelocque diameter of the pelvis and the obstetrical conjugate ranges from 4.93 to 13.5 centimeters. The great variation in this figure is shown in Figure 2, where it may be seen that the difference lay between 7 and 9 centimeters in only 51.3 per cent of the cases; in 11.3 per cent the difference was 6 to 7 centimeters, in 19.13 per cent it was 9 to 10 centimeters. In view of these facts which incidentally are not new but have been known since the days of Baudelocque it is perfectly apparent that the external conjugate measurement is not only useless but may be misleading and might well be discarded as an obstetric procedure.

If it be granted that the external conjugate measurement is of no practical value what measurement of the pelvis shall the practitioner of obstetrics employ in determining whether the pelvic inlet is normal or contracted? This question has been answered by Thoms with the statement that every primigravida should have the benefit of x-ray pelvimetry. It is certain that no method in common use equals x-ray pelvimetry in precision.

Thus Thoms, whose pioneer work in this field represents one of the most important advances in modern obstetrics has shown that the conjugata vera can be estimated by his x-ray method with an error of only 2 millimeters. Similarly Schumann has shown that the Thoms method is accurate to within 2 millimeters. Using the Hodges method of lateral stereoscopic x-ray pelvimetry, we have compared in 25 cases the obstetrical conjugate as measured by x-ray with the actual obstetrical conjugate as measured at operation by a specially devised pelvimeter. The results are shown in Table I where it may be seen that the average error was 0.16 centimeter, and the greatest error 0.3 centimeter in 15 out of the 25 cases the error was less than 0.2 centimeter.

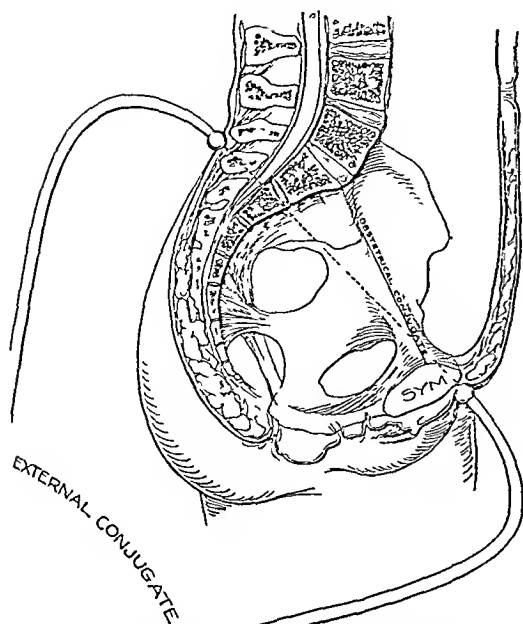


Fig 1 Sagittal view of normal pelvis showing the measurement of the external conjugate or Baudelocque diameter, this diameter does not lie in the same plane as the obstetrical conjugate

For ideal obstetrics then, there can be no question of the validity of these claims that every primigravida should have x-ray pelvimetry. But practically this would mean that some 625,000 x-ray studies on primigravida would have to be carried out each year in the United States alone. If this is necessary for the safety of our mothers, steps should be taken in some way or another to make it possible, but the important question arises, is x-ray pelvimetry necessary in every primigravida in order to determine whether the pelvis is adequate for the purpose of childbearing?

The most important single pelvic diameter in obstetrics is, of course, the obstetrical conjugate or the shortest anteroposterior diameter of the inlet. It is upon this measurement that Michaelis based all our modern knowledge of contracted pelvis. This diameter extends from the sacral promontory to the posterior aspect of the symphysis, but for obvious reasons can not be readily measured directly on the living patient. Since, however, it may be roughly computed from the diagonal conju-

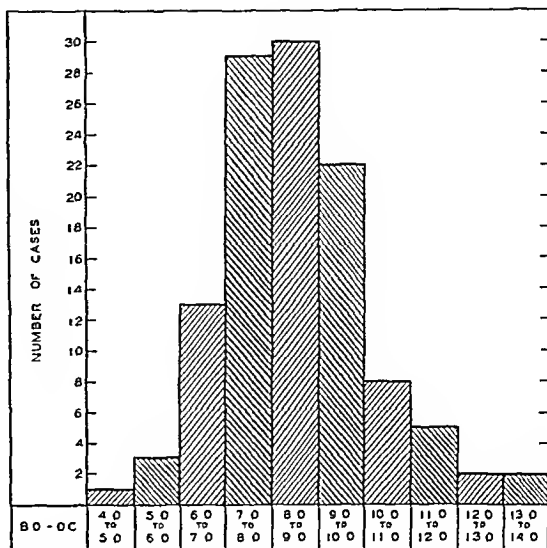


Fig 2 The distribution of the difference between the external conjugate (Baudelocque diameter) and the obstetrical conjugate (x-ray) in 115 cases. Mean difference is 8.53 centimeters, least difference 4.93 centimeters, greatest difference 13.5 centimeters

gate, as may be inferred from Figure 3, this latter measurement, the diagonal conjugate, has served as a basis for our classification of inlet contraction of the pelvis since the time of Litzmann. It will be recalled that the diago-

TABLE I—COMPARISON OF THE OBSTETRICAL CONJUGATE MEASURED BY X-RAY WITH THE ACTUAL OBSTETRICAL CONJUGATE MEASURED AT OPERATION

Case No	Obstetric conjugate actual cms	Obstetric conjugate x-ray cms	Error cms	Case No	Obstetric conjugate actual cms	Obstetric conjugate x-ray cms	Error cms
1	12.75	12.54	-0.21	14	9.88	9.70	-0.18
2	10.00	10.03	+0.03	15	11.38	11.36	-0.02
3	13.25	13.19	-0.06	16	10.00	10.30	+0.30
4	10.00	9.80	-0.20	17	11.50	11.82	+0.32
5	10.30	10.19	-0.11	18	10.55	10.79	+0.24
6	9.12	9.23	+0.11	19	8.50	8.25	-0.25
7	11.25	11.32	+0.07	20	11.25	11.02	-0.23
8	6.40	6.55	+0.15	21	9.38	9.22	-0.16
9	7.75	8.03	+0.28	22	10.40	10.50	+0.10
10	11.00	11.23	+0.23	23	12.20	12.17	-0.03
11	11.20	11.27	+0.07	24	11.10	11.38	+0.28
12	9.80	9.81	+0.01	25	10.91	11.06	+0.15
13	12.05	12.20	+0.15	Average error 0.16 cm			

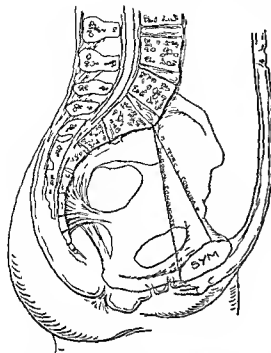


Fig 3 Sagittal view of pelvis to show the obstetrical conjugate and the diagonal conjugate diameter of pelvis

nal conjugate measurement is taken as is demonstrated in the accompanying diagram, Figure 4, and as is described in any textbook of obstetrics

In case the examiner can not reach the promontory of the sacrum, he should, nevertheless, direct his fingers toward the promontory and press his hand inward as far as possible. If at this moment he will take the measurement in the usual manner even though his finger has not reached the promontory, he will know that the diagonal conjugate measurement is greater than the figure he has obtained.

The figure to be subtracted from the diagonal conjugate in order to arrive at an estimate of the obstetrical conjugate is variable and depends upon 3 variations of the symphysis pubis, namely, its height, thickness and inclination, and upon one variation of the sacral promontory, i.e. its relation in level to that of the upper border of the symphysis pubis. Of these variations, those relating to the symphysis may be measured with at least some degree of accuracy, whereas the level

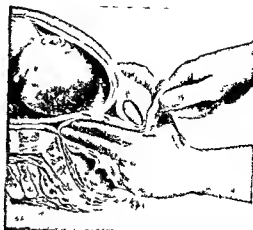


Fig 4 The measurement of the diagonal conjugate diameter. The tip of the middle finger is held against the sacral promontory; the base of the index finger is elevated to the undersurface of the symphysis; and the point where this finger passes beneath the symphysis is marked with the fingernail of the other index finger.

of the sacral promontory with relation to the superior border of the symphysis can be estimated only by palpation. As a result, there has arisen considerable difference of opinion as to the exact amount to be deducted from the diagonal conjugate in order to arrive at the value of the obstetrical conjugate diameter.

Basing their calculations on the general development of the bony pelvis or upon the height of the symphysis pubis, Michaelis, Eden and Holland, Edgar, and Polak recommended a deduction of 1.3 to 2.0 centimeters from the diagonal conjugate in order to arrive at an estimate of the conjugata vera. Jarcho uses 1.5 to 2.0 centimeters and these are the factors generally employed by both European and American obstetricians. Yamabe, determining from lateral roentgenograms, both diagonal conjugate and obstetrical conjugate measurements, found a difference varying from +0.5 to +2.4 centimeters with an average difference of +1.48 centimeters. Subtracting as the standard difference 1.5 centimeters from the diagonal conjugate he finds that in 90 per cent of the cases the obstetrical conjugate is obtained within an error of  $\pm 0.5$  centimeter. Jacobs found that in moderately contracted pelvis the true conjugate ap-

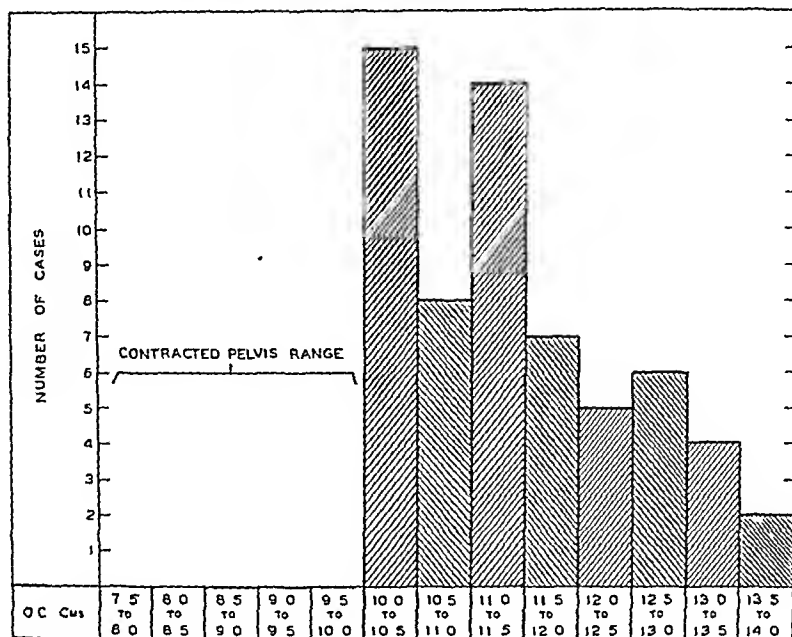


Fig 5 The distribution of the obstetrical conjugate measurement (x-ray) in 61 cases in which the diagonal conjugate was greater than 11.5 centimeters. Mean length of obstetrical conjugate is 11.41 centimeters, shortest length 10.0 centimeters, greatest length 13.72 centimeters.

proaches, equals, or exceeds in length the diagonal conjugate diameter.

It is the purpose of this paper to present evidence concerning the practical value of the diagonal conjugate measurement as an index of the adequacy of the pelvic inlet for childbirth. Does it give the practitioner sufficient information about the pelvis for clinical purposes or should it be superseded, in primigravida at least, by x-ray pelvimetry? The study includes 115 cases in which both the diagonal conjugate diameter and the obstetrical conjugate were measured, the latter from lateral stereoscopic films by the Hodges method.

In 61 cases, the diagonal conjugate measurement was found to be greater than 11.5 centimeters, i.e., it fell within the normal range of this diameter. In 15 of these patients the promontory was palpated, in the remainder it could not be reached but was measured as greater than 11.5 centimeters. Turning now to the obstetrical conjugate measurement in these 61 cases, it may be seen from Figure 5 that this diameter ranged from 10 to 13.72

centimeters. In the whole group there was no case in which the obstetrical conjugate measurement was below 10.0 centimeters, or in other words, no case in which there was an anteroposterior contraction of the pelvis of significant degree. This fact seems to us to have considerable practical importance because it means that the pelvis in which the practitioner has found the diagonal conjugate to be greater than 11.5 centimeters may be regarded as ample for childbirth in its anteroposterior diameter. Thus, in our opinion, a diagonal conjugate measurement which is found to be greater than 11.5 centimeters rules out anteroposterior contracture of the pelvic inlet.

When the diagonal conjugate measurement is 11.5 centimeters or less, it is important to know precisely what this diameter indicates in regard to contraction of the obstetrical conjugate diameter. Within the contracted pelvis range, the question we want answered is: How much is the obstetrical conjugate contracted? We have already indicated that considerable difference of opinion exists concern-

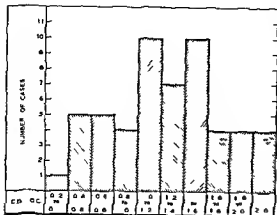


Fig. 6 The distribution of the difference between the diagonal conjugate and the obstetrical conjugate (x ray) in 54 cases in which the diagonal conjugate measured 11.5 centimeters or less. Mean difference is +1.6 centimeters; greatest difference +3.14 centimeters; least difference +0.2 centimeters.

ing the figure to be subtracted from the diagonal conjugate in order to obtain the obstetrical conjugate. In our total series of 115 cases, there were 54 instances in which the diagonal conjugate diameter was 11.5 centimeters or less. The difference between the diagonal conjugate and the obstetrical conjugate is shown in Figure 6. It is perfectly clear from this chart that this figure is not constant but ranges from +0.2 centimeter to more than +2.0 centimeters. In 27 cases or exactly one half it ranged between 1.0 and 1.6 centimeters, in 15 cases or more than one quarter it was below 1.0 centimeter, in 12 cases or more than one fifth it exceeded 1.6 centimeters. Within the contracted pelvic range then, the diagonal conjugate measurement does not yield the precision we should like in regard to the obstetrical conjugate. Indeed, a diagonal conjugate measurement of 10.5 centimeters may be associated in one case with an obstetrical conjugate of 10.2 centimeters and in another case with one of 8.2 centimeters. In the former instance, the patient would probably deliver spontaneously without difficulty, but in the latter she would likely meet with grave pelvic dystocia.

What then are we to conclude concerning the relative value of the diagonal conjugate measurement and x ray pelvimetry in obstetrics?

As we have indicated, it is our opinion that a carefully performed diagonal conjugate measurement which exceeds 11.5 centimeters rules out anteroposterior contraction of the pelvis. We do not feel that routine x ray pelvimetry is necessary in this class. It should be noted that into this group will fall more than 90 per cent of all white women. On the other hand, when the diagonal conjugate measurement is 11.5 centimeters or less, the information given by this diameter is only of an approximate character. It may be argued that there are so many other factors in labor, namely, the size of the baby and the character of the uterine contractions, that an approximation is enough. We do not agree with this viewpoint. The very fact that these other factors are difficult to evaluate accurately, makes it all the more important, in cases of contracted pelvis, that we should have as precise information as possible concerning the one factor that we can measure with precision. Accordingly, we believe that patients in whom the diagonal conjugate measurement is 11.5 centimeters or below, certainly when it is under 11 centimeters, should be given the benefit of that precision in pelvimetry which only x ray methods can yield.

#### CONCLUSIONS

1. The external conjugate measurement of the pelvis is a misleading obstetric procedure and might well be discarded.
2. The diagonal conjugate measurement is of great value for the reason that this diameter, when greater than 11.5 centimeters, rules out anteroposterior contraction of the pelvis.
3. When the diagonal conjugate diameter is 11.5 centimeters or less the information given by this measurement is of an approximate character only and x ray pelvimetry is desirable.
4. In measuring the obstetrical conjugate the Hodges stereoscopic method of x ray pelvimetry gives an average error of  $\pm 0.16$  centimeter and a maximum error of  $\pm 0.3$  centimeter.

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## REFERENCES

- 1 BAUDELLOCQUE, J L L'art des accouchements 1789, pp 76-90
- 2 DOHRN, R Ueber die Beziehungen zwischen Conjugata externa und Conjugata vera Monatschr f Geburtshk, 1867, 29-30 291-300
- 3 EDEN, T. W., and HOLLAND, E Textbook of Obstetrics 6th ed, p 374 New York The Macmillan Co, 1925
- 4 EDGAR, J C Pelvic deformity in New York Tr Am Gynec Soc, 1902, 27 324
- 5 JACOBS, J BAY The borderline pelvis Am J Obst. & Gynec, 1937, 33. 778-787
- 6 JARCHO, JULIUS The Pelvis in Obstetrics; A Practical Manual of Pelvimetry and Cephalometry Including Chapters on Roentgenological Measurement, p 193 New York Paul B Hoeber, Inc, 1933
7. MICHAELIS, G A Das enge Becken Edited by C C T. Litzmann Leipzig. Weigand, 1851.
- 8 POLAK, J. O Manual of Obstetrics New York. D Appleton & Co, 1913
- 9 SCHÜBERT, E von Ueber die Bewertung der Conjugata externa (Diameter Baudelocquii) in der Geburtshilfe Arch f Gynæk, 1934, 155: 490
10. SCHUMANN, E A The size and shape of the pelvic inlet as determined by direct measurement Am J Obst & Gynec, 1936, 32 832-835
- 11 SKUTSCH Quoted by Stander Williams' Obstetrics 7th ed, p. 954 New York D Appleton-Century Co, 1936
- 12 THOMAS, H The Obstetric Pelvis Baltimore The Williams & Wilkins Co, 1935
- 13 YAMABE, A. Roentgenpelvimetry and its application in obstetrics Japanese J Obst & Gynec, 1937, 20. 52-90





# PAUWELS' RECLINATION, A PHYSIOLOGICAL RECONSTRUCTION FOR NON-UNITED FRACTURE OF THE NECK OF THE FEMUR

GEORGE J. KARFIOL, M D, San Francisco, California

**N**UMEROUS methods of treatment for non union of the neck of the femur have been advised and employed. Chief among these are (1) those of the osteosynthetic method: sutures, short metal, bone or ivory pins or screws, grafts, Kirschner wire, the Smith Petersen nail, the method of Boehler, Sven Johanson, etc., (2) plastic resections and extirpations of the head, and (3) reconstruction operations such as those of Albee, Brackett, and Whitman, with their various combinations and modifications, as well as those advocated by Froehlich, Spitz, Lexer, and many others.

Although many requirements for an ideal treatment of fractures have been achieved, and many studies have been made of the anatomical conditions of the neck of the femur in relation to the formation of callus, the chances for direct stimulation of such formation have not been improved very considerably. Another approach, therefore, proved to be of great importance in the further development of this problem: namely a method of supportive osteotomy presented by Lorenz and Schanz.

Lorenz rediscovered an operation the description of which was first published in 1894 by Kirmisson in the *Revue d'Orthopédie*. This operation had been used by Hoffa, Drehmann and Froehlich but had been forgotten. Lorenz saw as an important factor of his "bifurcation" the support given to the acetabulum by the angle of the osteotomy fragments. Baeyer who developed the same method, believed the increased tension of the psoas-trochanteric muscles to be the most important factor. Schanz used another osteot-

omy which provided support for the lower border of the pelvis by angulation of the fragments of the femur. This subtrochanteric osteotomy, originally worked out for the treatment of congenital dislocation of the hip, results in artificial lengthening of the leg, abduction, and prevention of further upward gliding of the head. Hass modified the method of Lorenz and Schanz and recommended the intertrochanteric osteotomy.

These methods, already suggested as means of support to the pelvis, thereby reducing the weight bearing of the head, and the reconstruction of the physiological relations of muscle, led finally to the work of Pauwels, Camitz, and McMurray.

The operation which Camitz (Gothenburg) described in a publication, 1931, was based on observations on the gliding mechanism of the trochanter, which caused a steady up and down movement in the fracture line, and thus led to resorption and necrosis. Camitz performed a straight or wedge shaped extra-capsular osteotomy in the upper part of the femur with an angulation of the fragments of from 20 to 30 degrees in order to restore the support of the weight of the body to its normal place under the center of the acetabulum.

This was also McMurray's idea, and the results of the two operations are almost identical. Both of these methods of osteotomy considered the damaging influence of shearing forces upon the fragments and tried to eliminate them as nearly as possible. One decisive factor in the maintenance of the non-union was improved thereby, namely the mechanical alterations and correlations of the fragments. The factor remaining was the ability of the bone to form callus.

Pauwels attacked the problem by constructing new physiological conditions which might, through their mechanical efficiency,

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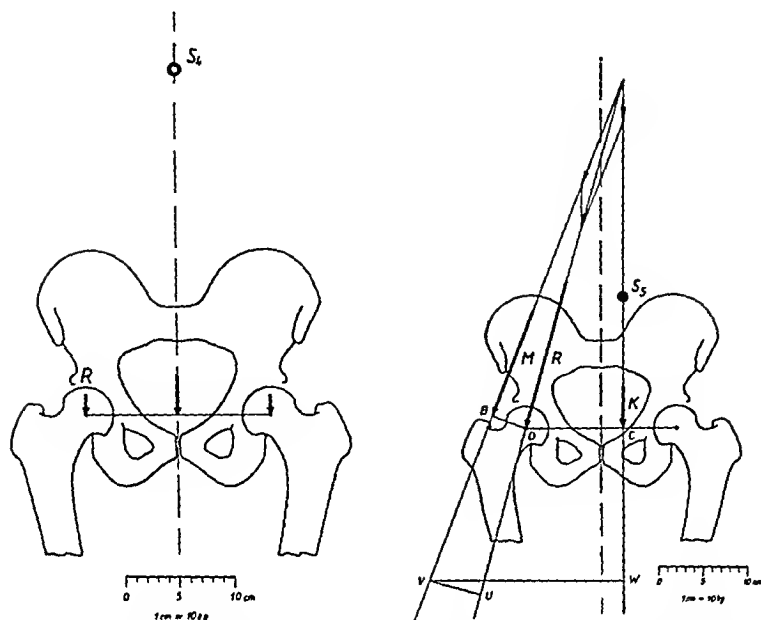


Fig 1, left Drawing showing the direction and quality of pressure,  $R$ , acting on the heads of both femurs as the subject stands on both legs  $S_4$  is the point of gravity

Fig 2 Drawing demonstrating the change in the direction of the pressure on the head of the femur as the subject walks  $R$ , is the pressure on the head,  $M$  indicates the muscle forces in effect, and  $K$ , the proportional weight of the body  $S_5$  is the point of gravity

increase the ability of the bone to form callus and, at the same time, give sufficient stability and support to the pelvis. In 1929, he published the first reports on the actual proportions of strength and effectiveness of those forces which influence regeneration of the fractured neck of the femur. In these reports he demonstrated how, depending on their strength and quality, mechanical forces influence the healing process.

The basis of Pauwels' ideas is the law of Roux, the anatomist, namely, that functional pressure promotes the formation of bony callus, while, on the other hand, tension or shearing force not only inhibits the formation of callus but also stimulates the formation of fibrous connective tissue. This law is of special importance in dealing with the neck of the femur because of its particular anatomical construction.

In brief, Pauwels' conclusions on the mechanical relations of the fracture and femoral neck are: The head of the femur is

exposed to a certain amount of pressure in a vertical direction, which changes greatly with the position of the body. Figure 1<sup>1</sup> shows the direction of this pressure,  $R$ , with a normal and symmetrical stand on both legs. During the period of standing on one foot while walking the direction of pressure changes as is demonstrated in Figure 2.  $S_5$  is the point of gravity,  $K$  the proportional weight of the body,  $M$  the effective muscle forces. These relations differ greatly under pathological conditions. In a limping walk due to a disturbance to the hip, the general distribution of forces is as shown in Figure 3, *f i*.

When the neck of the femur is fractured, the general pressure force,  $R$ , is divided into two partial forces (Fig. 4), the actual pressure component,  $P$ , and a shearing component,  $S$ , which has the gliding tendency. Both of these are important because of their biological effect on the formation of new bone, and the course

<sup>1</sup>Figures 1 to 6 are taken from Pauwels' *Der Schenkelhalsbruch, ein mechanisches Problem*

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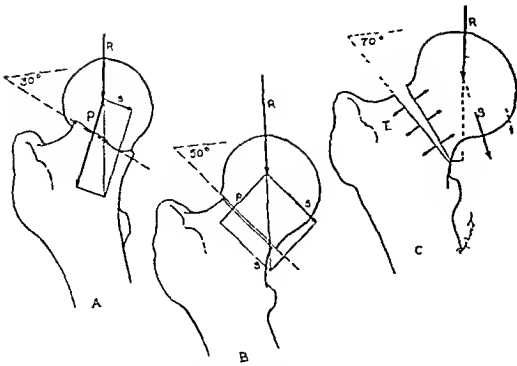


Fig 5 A, Drawing showing a fracture of the first degree, the angle of the fracture line is 30 degrees. Only the pressure force is in operation. B, A fracture of the second degree, the angle of the fracture line is 50 degrees. Only the shearing force *S* is in operation. C, A fracture of the third degree in which the angle of the fracture line is 70 degrees. The shearing force, *S*, and the tension force, *T*, are both in operation.

of the formation of callus. The technical, merely preparatory, procedure of reclamation is accomplished by means of Schanz' high subtrochanteric osteotomy.

The procedure is as follows. The degree of the angle between the line of the fracture and the transverse diameter of the pelvis is determined. The roentgenogram is best taken when the patient is in a standing position with the legs parallel. If such a film cannot be obtained, the method as demonstrated in Figure 7 will give satisfactory results. In order to achieve an angle of less than 30 degrees the number of degrees the fracture line must be decreased is calculated. An osteotomy either straight or wedge shaped is performed below the lesser trochanter. Prevention of later self-straightening of the fragments, as has been frequently seen, makes a removal of a wedge advisable.

The most important orthopedic procedure actually consists in rotating the head of the femur and the fracture line downward to the angle determined necessary for an effective direction of pressure force, this can easily be done by rotation of the head halfway downward and the rest of the correction may be obtained by abduction of the distal fragment of the shaft. The osteotomy fragments are fixed in the desired position. The use of Schanz' screws or pins, which are later incor-

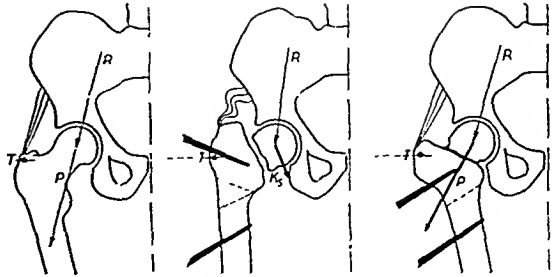


Fig 6 Drawing illustrating the effects of the change in the angle of the fracture line. A shows the normal conditions, the physiological body-gravity, *R*, and its pressure, *P*, upon the head of the femur, the position of the greater trochanter, *T*, and the physiological tension of the pelvotrochanteric muscles. B shows the conditions existing in non-union of the neck of the femur, the free acting shearing force *Ks*, the upward displacement of the greater trochanter and the disarrangement of the coordination of the pelvotrochanteric muscles. C, After the reclamation operation, the pressure force *P*, is again in operation, the free shearing force has been eliminated, downward replacement of the greater trochanter has been accomplished, further displacement is prevented, and the pelvotrochanteric muscles are again coordinated.

porated into the cast, is very helpful. One is driven into the upper fragment, connecting the greater trochanter and the head of the femur, which facilitates the rotation of this part and prevents moving or slipping of the head. The other pin is placed below the site of the osteotomy. These pins not only allow exact measuring of the angulation, but also guarantee dependable fixation. These two factors, rotation of the fracture line and fixation of the osteotomy fragments, are the important features for achieving the expected result of the reclamation.

The rest of this operation is technically very simple. The proximal screw should be inserted at a right angle to the femur. The distal screw is placed at an angle of 90 degrees minus the angle around which the fracture line is to be rotated. This allows the lower screw to be brought parallel to the upper one after the osteotomy (Fig 8). If a wedge shaped osteotomy is done, the point of the wedge should be directly underneath the trochanter minor. It is advisable to make the distal line of the wedge more or less straight transversely with the upper line slanting downward. This will prevent an upward gliding of the distal fragment before the cast is applied.

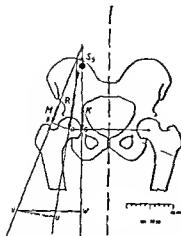


Fig 3 Drawing showing the distribution of the forces illustrated in Figure 2 in a subject who walks with a limp caused by injury to the hip (see Fig 2)

of the process of healing will be determined by which of these 2 forces is predominant. According to the law of Roux if the shearing force outweighs the pressure force, the growth of bony callus will be prevented but formation of connective tissue will be stimulated. This shearing tendency also causes a tractive force, either of which is able to transform even well developed bony tissue into faulty connective tissue.

The effect of free shearing force varies greatly since it depends on the direction of the fracture line that is the angulation of the fracture line in relation to the transverse diameter of the pelvis. Pauwels proved that this force becomes effective first when the angle is about 25 degrees. At a smaller angle, functional pressure alone acts upon the regeneration. With an increasing angle there is less pressure and increased shearing.

The head fragment can be exposed to 3 mechanical forces different in principle: namely, pressure, shearing and tension. For purposes of prognosis and therapy, therefore, 3 groups of fractures can be distinguished: (1) Fractures of the first degree in which the angulation of the fracture line to the transverse diameter of the pelvis is 30 degrees or less. The mechanical force results in functional pressure only or at least predominantly upon the zone of regeneration. (2) Frac-



Fig 4 Drawing showing the change in the pressure force after fracture of the neck of the femur.  $R$  (see Fig 1) is now divided into the pressure component  $P$ , and a shearing component  $S$ .

tures of the second degree with the angle of the fracture line above 30 degrees. The mechanical force in this fracture is free shearing,  $S$ , and the force of pressure does not operate. (3) Fractures of the third degree in which the fracture line is usually above 70 degrees. In these cases the mechanical force is that of free shearing  $S$ , combined with traction or tension,  $T$ , thus constituting two injurious forces (Fig 5).

As Pauwels found that free shearing force is almost eliminated when the angle of the fracture line is less than 30 degrees, any therapeutic procedure should diminish the existing angle to one of 30 degrees or even less so that only the pressure component will act upon the fragments. The operation fulfilling these conditions is called "reclination". Its object is to transform the existing fracture into a fracture of the first degree according to the classification given above so that the mechanical force, existing in the non union, is changed from shearing or tension to functional pressure. The operation of reclination is therefore different from all other methods because instead of merely applying support to the fracture in an attempt to induce healing, this operation utilizes a new principle: functional pressure as a healing agent.

The orthopedic significance of the Pauwels operation is the change in the mechanical set up to obtain a physiological basis for the healing of the fracture. The angle of the fracture line in relation to the transverse diameter of the pelvis is changed so that it becomes less than 30 degrees. This leads not only to correction and adjustment of anatomical features but also to a physiological stimulation

injury does not seem to make much difference in the final result, in the literature are reports of cures 2½ years after the fracture. One of my own patients (Case 1) was operated on 6 years after injury.

As has been explained, reclamation is expected to result in physiological stimulation of the formation of callus and stabilization of the fracture. Moreover we find the following secondary results no less important: (1) increased abduction of the injured leg; (2) lengthening of the leg to partial or full correction of the shortening, and (3) disappearance of the Trendelenburg phenomenon.

The elimination of the shearing force is the primary requisite for a successful osteotomy of the neck of the femur. The various types of osteotomy advised for these non-united fractures have proved successful for the most part. Although devised primarily to relieve the head of the femur by giving additional support, they also resulted usually in the elimination of shearing forces. It is this feature which made them successful. Gaenslen, who first mentioned the name of Pauwels in the American literature, advocated Schanz's high subtrochanteric osteotomy, "provided that the distal fragment of the neck can be so placed as to provide an under pinning for the head and, therefore, an elimination of the shearing action at the fracture site." While this is possible only when the angle of the fracture line is reduced, Pauwels' reclamation has the latter as its starting point. Naturally, there can be no one method of treatment for the non-united fracture of the neck of the femur, for every different kind of fracture has its special mechanical correlations. It is necessary, therefore, to know the acting forces and their mechanical effectiveness in each case.

The results of the reclinations done so far have proved very satisfactory. The comparatively simple procedures which make the exposure of the joint, capsule, or fracture line unnecessary, considerably reduce the risk of any major operation of this type.

It has been demonstrated that after the reclamation operation, even a fibrous union may be transformed into real bony tissue which is proof of the effectiveness and im-

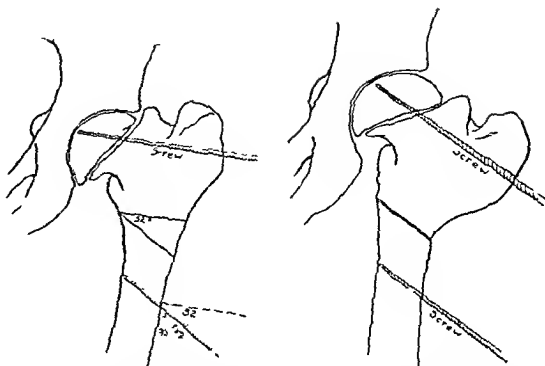


Fig 8 A, left The proximal screw should be inserted at a right angle to the femur, and the distal screw at an angle of 90 degrees, minus the angle around which the fracture line is to be rotated. B, After the osteotomy the 2 screws are parallel.

portance not only of the mechanical forces but also of the change and restoration of the physiological forces. The knowledge that mechanical forces decidedly influence the healing process of the fractured neck of the femur brings the problem considerably closer to a solution, improves the prognosis, and after more experience, will probably greatly affect our indications for operation.

#### CASE HISTORIES

**CASE 1** (Figs. 9, 10) S M., a tailor, 52 years of age, was first seen in September, 1935. Six years previously he had fractured the neck of the left femur. He wore a cast for 3 months, then began to walk with a spica cast applied from hip to knee. After 2 months of this, he walked with crutches and later with a cane. He was unable, however, to walk more than 3 or 4 blocks without becoming tired and suffering pain in the left hip. This had become worse during the last 2 years.

On examination, the left leg was found to be 1½ inches shorter than the right and the muscles were atrophied. Flexion of the hip joint was 25 degrees, abduction 20 degrees, and adduction 15 degrees. The Trendelenburg phenomenon was positive. X-ray examination showed a non-united fracture of the neck of the left femur.

Pauwels' reclamation was done on October 29, 1935, and, on December 10, the cast was removed from the knee down. Six days later the screws were removed and, on December 24, the remainder of the cast was taken off. Within a week the patient was allowed to sit on the side of the bed, and on January 1, 1936, he was able to walk with crutches. On the sixteenth he was discharged from the hospital, using canes. One week later he returned to his work as a tailor and, a month after his discharge from the hospital, he was able to walk without the use of a cane.

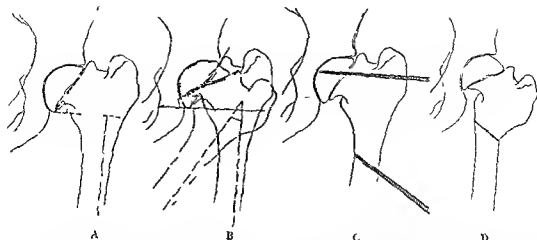


Fig. 7 Drawing to illustrate the calculation necessary for the Pauwels operation. A The angle of the fracture line to the transverse diameter of the pelvis is 60 degrees. B The angle of the fracture line is rotated so that it be-

comes less than 30 degrees (in this instance 25 degrees). A rotation of 32 degrees was required. C To accomplish the rotation required a wedge with an angle of 32 degrees at the point is removed. D The end result.

One of the advantages of this operation is that minor technical failures do not affect the end result. In the first case done in California the displacement mentioned occurred—that is, slipping of the distal fragment. The x-ray film (Case 1) showed a result almost like that of a bifurcation yet there was no delay or disturbance in healing. Neither does it matter whether the site of the osteotomy is chosen slightly above or below the determined place, a factor which in other types of procedures may doom the operation to failure.

In addition to those mentioned, other advantages are. The original fracture and the osteotomy fragments are firmly fixed by means of the pins or screws which are incorporated into the cast (a single spica including the foot). Any motion of the fragments is prevented and the patients suffer no pain. They can easily be moved in bed without great discomfort so that the treatment during the entire period in which the cast is on can be managed easily and comfortably. The patient can be turned upon his abdomen frequently if he chooses or if delayed bowel movement makes it necessary.

In the average case a slight formation of callus around the osteotomy should be present by the sixth week after operation. At this time the screws are removed. Two days later

the cast is opened and the patient remains for 2 or 3 days in the lower shell which is then removed. Almost from the beginning the patient is advised to exercise his quadriceps muscles and is taught to do so. In most cases I removed the lower part of the cast, from the knee joint down about the third or fourth week and advised exercises to prevent stiffness in the knee after removal of the cast. Such stiffness will delay the entire progress. After the seventh or eighth week the patient should be able to be out of bed part of the time. Any forced movements are strictly forbidden. The patient may receive some heat and careful massage and should be able to move about on crutches after 5 or 6 days. After walking about 2 weeks with crutches in the hospital he should go home with canes that is at or about the tenth week after operation.

It is not necessary to wait until callus has formed in the fracture; this usually takes several months, but in spite of this fact the bearing power of the injured leg will develop surprisingly fast and a comparatively fast resumption of work can be expected. A tailor (Case 1) and a secretary (Case 2) were able to work 12 weeks after the operation. Patients between the ages of 12 and 65 years have been operated on and no failures have been reported so far. The length of time after the



Fig 11 (Case 2) A, Roentgenogram showing the patient's condition before operation, 2½ years after injury

B, Roentgenogram taken 5½ weeks after operation  
C, Roentgenogram taken 15 months after operation.

tion was performed and a cast applied. The patient used a walking caliper brace until May, 1937, when the roentgenogram showed non-union still present.

On May 24, 1937, Pauwels' reclination was done. On July 8, the screws were removed and 1 week later the cast was taken off. Within a week he was able to walk with two crutches and early in August he used only one cane. In October, he was discharged to return to duty which would not require long periods of walking or standing.

CASE 5<sup>1</sup> Mrs T B, 45 years of age, had a fracture of the neck of the left femur on December 24, 1936. It was reduced and a cast applied. The patient remained continuously in bed for 5 months when x-ray examination showed non-union of the fracture.

On May 24, 1937, Pauwels' reclination was done. On July 8, the screws were removed and 1 week later the cast was taken off. The osteotomy had united, but there was a contracture of the left knee, the

<sup>1</sup>Patient of Dr E M Townsend

right knee was slightly affected also. The patient was very nervous, both legs were tender, and she refused to attempt any exercises. For many weeks she could not stand, even with the support of crutches. By December, 1937, however, she was able to walk comfortably on crutches.

CASE 6 (Fig 13) Mrs G B, 36 years of age, sustained a fracture of the neck of the right femur in March, 1933. Traction was used, then a Whitman cast, and finally a supportive walking brace. A roentgenogram made in January, 1934, showed non-union. Pauwels' reclination was done on April 11, 1934, and the patient left the hospital 10½ weeks later. Within 4 months after discharge she was able to engage in her usual activities.

CASE 7<sup>2</sup> (Fig 14) G D, a lumber worker, 56 years of age, fractured the neck of the right femur on April 11, 1937. A Whitman cast was applied, but on July 28, no union had occurred. Pauwels' reclina-

<sup>2</sup>Patient of Dr John and Dr Edward LeCocq, of Seattle

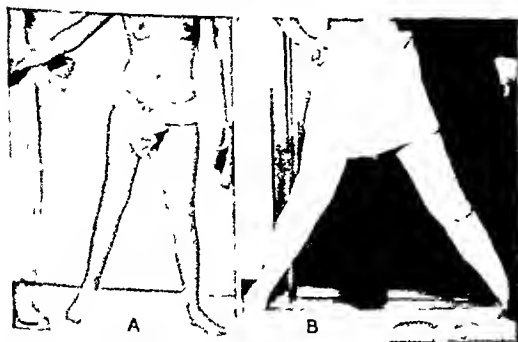


Fig 12 (Case 2) A, Before operation, B, 15 months after operation



Fig 13 (Case 6) A, left Roentgenogram 9 months after accident, before operation, B, 6 months after operation





Fig. 9 (Case 1) A Roentgenogram showing the condition before operation more than 6 years after the accident B, 4 weeks after operation C A year and a half after operation

Examination 9 months after his discharge showed the left leg to be only half an inch shorter than the right abduction was 40 degrees and the Trendelenburg phenomenon was negative He was able to stand on the left leg without difficulty and walked with no pain or discomfort His limp was very slight

CASE 2 (Figs 11, 12) Miss H C 30 years of age fractured the neck of the right femur in October 1933 She wore a cast for 3 months but had no further treatment She used crutches for 5 months Fourteen months after the injury she first noticed discomfort and a cracking sound in the right hip which disappeared Six months later discomfort and the cracking became worse so that she began to limp and within a few months she was unable to walk without crutches She could bear no weight on her right leg

Examination in February 1936 showed the right leg to be  $1\frac{3}{4}$  inches shorter than the left and muscular atrophy was noted There was no abduction or rotation and flexion was limited to about 60 degrees X ray examination showed a non united fracture of

the neck of the right femur with atrophy of the head and arthritic changes of the head and acetabulum

Pauwels' reclination was done on February 5 1936 After 4½ weeks the lower part of the cast was cut off and the screws were removed a week later The remainder of the cast was taken off on March 21 Because of pyelitis and nephrolithiasis the patient was unable to be out of bed until April 2 when she began to walk with crutches Two weeks later she was discharged from the hospital able to walk with the aid of 2 canes and by May 1 she resumed her work as a secretary

This patient was examined again on July 1, 1936 At that time she walked comfortably without support suffered no pain and had a scarcely perceptible limp The right leg was about three quarters of an inch shorter than the left The Trendelenburg phenomenon was not evident

CASE 3 F W B, a painter 49 years of age suffered a fracture of the neck of the right femur in May 1935 Traction was applied and a Thomas splint was used A week after the accident, a Whitman reduction was performed and a cast was applied In September he began to walk on crutches with the aid of a caliper brace Two months later a roentgenogram showed non union and an increased absorption of the neck of the femur

On December 5 1935 Pauwels' reclination was performed and on January 27 the cast was removed from the knee down On January 31 the screws and the rest of the cast were removed Four days later he was able to be up on crutches He had unusual difficulty in adducting the right leg and flexing the right knee On March 20 1936 he was discharged from the hospital At present he has neither pain nor discomfort and walks with a very slight limp

CASE 4 F F, a seaman 22 years of age fractured the neck of the right femur on August 28 1936 Traction was employed for 1 month then manipula-

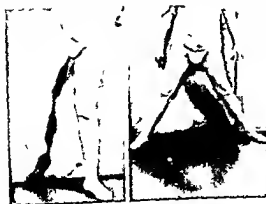


Fig. 10 (Case 1) Nine months after operation

ing to non-union. Their damaging action cannot only be eliminated but can actually be transformed into physiologically important pressure forces by changing the mechanical requirement, that is by decreasing, to less than 30 degrees, the angle of the fracture line to the transverse diameter of the pelvis. This operation, called reclamation, is accomplished by means of Schanz' high subtrochanteric osteotomy.

The results expected and obtained in all the patients operated on so far, are

1. Physiological stimulation of the formation of callus as a result of the elimination of the shearing forces and the substitution of pressure forces upon the fragments

2. Prevention of further displacement through upward gliding of the fragment of the shaft

3. Stability of the affected leg with the safe bearing of weight

4. Reconditioning of the pelvotrochanteric muscles

5. Downward replacement of the greater trochanter

6. Increased abduction of the injured leg

7. Artificial lengthening of the leg

8. Disappearance of Trendelenburg's phenomenon

In addition the reclamation operation has certain advantages not found in other methods

1. The operation is technically simple and can be performed in a comparatively short time

2. There are few chances for technical failure

3. There is little pain after the operation

4. The management of treatment during the period when a cast must be worn is easy, as is the after-treatment

5. The period of hospitalization is comparatively short, (usually from 10 to 11 weeks)

6. Early bearing of weight may be permitted, it is not necessary to wait for the formation of callus

7. The patient may return to work comparatively early

I wish to express my thanks to Dr. L. D. Prince, Dr. E. M. Townsend, chief surgeon of the U. S. Marine Hospital, San Francisco, and to Dr. John and Dr. Edward LeCocq, of Seattle, for their co-operation in allowing me to use their material for operation and presentation of these cases

## REFERENCES

1. BRANDES, M. Erfahrungen zur operativen Behandlung der Schenkelhals Pseudarthrose nach Pauwels. Zentral Org f d ges Chir u Grenzgeb, 1935, 72 396
2. CAMITZ, H. Die Pseudarthrosen (nebst wahrscheinlichen Vorstadien) nach medialen Frakturen des Collum femoris und deren Behandlung. Acta chirurgica, 1931, 68 19
3. GAENSELEN, J. The Schanz' subtrochanteric osteotomy for irreducible dislocation of the hip. J Bone & Joint Surg, 1935, 17 76
4. HILLEBRAND, H. Ein weiterer Beitrag zur Behandlung der Schenkelhalspseudarthrose. Abwinkelung nach Pauwels. Beitr z klin Chir, 1933, 157 281
5. MAGNUS, G. Behandlung der Schenkelhalsfraktur. Deutsch med Wchnschr, 1936, 1 957
6. McMURRAY, T. P. Ununited fractures of the neck of the femur. J Bone & Joint Surg, 1936, 18 319
7. PAUWELS, F. Eine neue methode zur Behandlung der Schenkelhalspseudarthrose. Ztschr f orthop Chir, 1929, 51 125
8. Idem. Grundlagen des Heilungsvorganges bei Schenkelhalsbruechen. Verhandl d deutsche orthop Gesellsch, 1934
9. Idem. Der Schenkelhalsbruch, ein mechanisches Problem. Ferdinand Enke, 1935
10. SCHANZ, A. Zur Behandlung der Schenkelhalsbrueche. Arch f klin Chir, 1907, 83 336
11. Idem. Praktische Orthopaedie. Berlin Julius Springer, 1928
12. SCHUMM, H. P. The Schanz osteotomy for fractures of the neck of the femur. J Bone & Joint Surg, 1937, 19 4
13. TREVES, A. L'osteotomie sous trochantérienne "en console" dans les pseudarthroses du col du femur. Reunion d'orthop et de chir de l'appar moteur, Bordeaux, 1932, 9 6



Fig 14 (Case 7) A Roentgenogram taken 3 months after the accident before operation B, Roentgenogram taken 3 1/2 weeks after operation C Roentgenogram 8 weeks after operation

tion was done on August 1. Seven weeks after operation the screws were removed and a week later the cast was taken off. Two days after removal of the cast the patient was up on crutches. On October 6 however the patient was dropped by a hospital employee and had to be kept in bed for several weeks. He was discharged from the hospital on November 3, 1937 still using crutches. By January, 1938 he was able to walk without support.

All these patients had satisfactory results as to the expected features. The youngest patient was 22, the oldest 56 years of age. The latter (Case 7), was operated on soonest after injury (4 months). It was felt that the delayed union would lead to a long period of disability even if a later union should occur, and that the operation might shorten the convalescence. Case 1 is interesting because it demonstrates that, even 6 years after the fracture the defectively built union between neck and head was gradually being transformed into bony callus. Because of the increased stability after the operation this man as well as the patients described in Cases 2, 4 and 6, were able to start work long before the formation of callus was evident in the roentgenograms.

Two patients had never walked during the time between the accident and the operation. A third one walked a few months with crutches and caliper brace (Case 3). He had

difficulty mostly in adduction of the affected leg and flexion of his knee joint which caused some delay in his return to work. Stability and weight bearing were satisfactory about 10 weeks after the operation. In Case 3 there was an unusual weakness and atrophy of both legs as well as stiffness of both knee joints. Several weeks after the cast was removed sufficient stability of the leg could be proved weight bearing was possible, and passive motions in all directions had greatly improved. Yet there was extremely slow progress in walking. In Cases 3 and 5, the full length of the cast was kept on for about 1 week, a fact which indicates the importance of the early use of motion and exercises, especially of the knee joints. Even though the patient might be slightly more comfortable in the full length of the cast it is advisable to remove the cast from just above the knee downward at about the third to fourth week. This procedure is particularly wise in those patients who before the operation, show either marked muscular atrophy or limitation of the mobility of the knee.

#### SUMMARY

Pauwels found that shearing and traction forces decidedly hinder the healing processes of the fractured neck of the femur thus lead

considered mentally and physically unsuitable for they will prove as unsatisfactory as do similar patients with any plastic operation. The complications to be feared should be carefully explained to the patient before operation. In our experience they have not been serious but may be troublesome. Despite the magnitude of the operation there has been no mortality and the dangers are purely those of a general surgical nature. The commonest is necrosis of areas of the skin flaps used in the reconstruction, but with improvement in technique and care taken not to make these skin flaps either too thin or too long this should rarely occur. Partial necrosis of the pedicles or the nipple is now a rare complication and occurred more frequently when the external breast pedicle was utilized. Despite the size and importance of the long thoracic artery, its value as a source of supply to the nipple and areola is not great. The nipple largely depends on the perforating branches of the internal mammary artery. Partial necrosis of the breast pedicle itself is unquestionably the result of bad technique. Either the blood supply has been cut down too much, or the pedicle rotated too abruptly with interference to the blood supply. Hematomas may occur but are unusual if hemostasis has been carefully attended to and drainage instituted for 48 hours. Sepsis is uncommon and is usually the result of a hematoma or an infected stitch. The treatment of these complications will be dealt with later.

#### PRE-OPERATIVE PREPARATION

On the evening before operation the entire chest, back and front, is prepared together with the arms and upper part of the abdomen, ether, soap, and spirit being used. The whole area is painted with acriflavine solution 1:1000 and covered with a sterile jacket. This treatment is again applied on the operating table.

#### OPERATING PRINCIPLES

The surgical ideal is not only to reduce the breast to a normal size but to restore it as far as possible to its classic shape, retaining as much of its normal function as possible. To do this the breast tissue and the covering skin constitute two separate problems. Reduction in the amount of breast tissue is carried out in two ways.

a Resection of the lateral half of the breast preserving the perforating branches of the internal mammary artery to form a freely vascular internal pedicle with the nipple and areola near the most dependent portion.

b Resection of the upper and middle portion of the breast to form a double shaped pedicle so

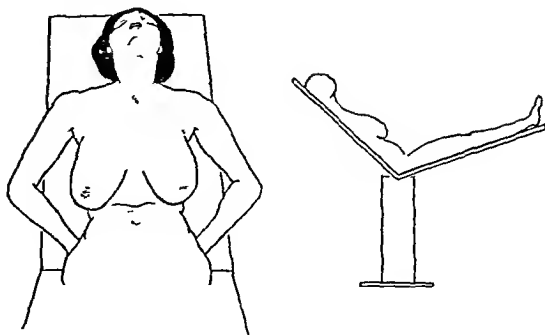


Fig 1 Operative position half sitting with arms spread to give access to axilla. Breasts dependent

preserving the lateral thoracic artery in addition to the medial blood supply and carrying the nipple at the apex of the U.

Reduction of the covering skin has also taken two forms.

a A single upper flap through which the nipple is transposed thus giving a single transverse scar in the submammary line.

b Double lateral flaps with excision of an inverted V shaped portion between the nipple and the transverse submammary incision. The former is to be preferred if the transverse scar can be made so short that it does not project into the axilla. It is inconspicuous, does not limit movement in the breast in any way, and except in its most lateral portion is not usually hypertrophic in character. Two stages are almost always required for its satisfactory use. The latter has the advantages of producing a better shaped breast with a shorter submammary transverse scar, and the operation can more frequently be performed in one stage than with the single upper flap.

#### SELECTION OF TYPES OF OPERATION

The internal pedicle is used in almost all cases and has been found entirely satisfactory as a means of preserving the blood supply of the nipple. The double pedicle has its particular field in those cases in which general obesity is a factor and in which a well marked axillary fold is characteristic of that individual. Here it is as well to make a breast in keeping with the type of body habitus of the patient rather than attempt to construct something of more classical proportions. Formerly we adhered as far as possible to the single upper flap method of skin reconstruction because we felt that the cosmetic result was better without a vertical scar and the liability to skin necrosis less. Since we have adopted the manual method of skin separation, however, necrosis has practi-

# CLINICAL SURGERY

FROM ST BARTHOLOMEW'S HOSPITAL

## THE TECHNIQUE OF MAMMAPLASTY IN CONDITIONS OF HYPERTROPHY OF THE BREAST

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**T**ODAY there is little need to justify plastic surgical procedures on the pendulous breast. It is a field as genuine as any other in reconstructive surgery provided its limitations are recognized and the cases are carefully selected. Mammary hypertrophy and ptosis probably result from hereditary influences, glandular excesses or deficiencies, repeated pregnancies, obesity, or other factors acting on a poorly fixed structure. A constantly repeated series of physiological changes gives little opportunity for the recovery of lost tone. The retro-mammary fascia and suspensorium mammae are in themselves weak supports and are unable to sustain any prolonged increase in the weight of the breast. The skin, probably the most important of the fixative structures, must retain its tonal quality and elasticity if increase in gland weight is not to be followed by stretching and mammary descent. The difference between the ordinary ptotic breast and the huge hypertrophy of gynaecomastia is probably determined by these hereditary and mechanical factors and the degree of endocrine influence.

### TYPES OF MAMMARY HYPERTROPHY

- 1 Long flabby pendulous breasts with or without glandular hypertrophy of the most dependent portion and characteristic of the adolescent girl of otherwise normal build. Such breasts in all probability are of purely hereditary and endocrine origin.
- 2 Broad heavy breasts which develop with obesity and are associated with it and with pregnancy.
- 3 Sac-like dependent breasts following obesity, reduction and pregnancy.
- 4 True gynaecomastia. A hypertrophic condition of the glandular elements of the breast resulting in one of enormous proportions. These cases are not common.

### 5 Asymmetry. This is probably a congenital deformity.

Primarily the indications for operation are concerned with the undesirable symptoms produced by the size of the breasts themselves i.e. weight, general tiredness, backache, faulty posture, sub-mammary intertrigo and so forth. Many of these enlarged breasts are painful, and the patient can be observed in the out-patient department of the hospital supporting the breast with her hand while waiting for examination. Limitation of social activities are of importance, for riding, swimming and dancing become impossible and the patients often exhibit psychic disturbances as a consequence. It is prudent, however, to be cautious with many of these patients for we are dealing with a type in whom no plastic operation should be undertaken without great circumspection. It is important to discriminate carefully between those who will derive lasting benefit and happiness from operation, and those who will never be satisfied whatever is done. The procedure should be fully explained to the patient and the nature of the scars shown to her, if possible, by means of photographs, so that she fully realizes what the end result will be.

This is an operation of considerable magnitude. It is done largely for the comfort of the patient so that if it is worth while the risk must be correspondingly small. The patient must be in good health prior to operation and the operation itself conducted under ideal circumstances. Complete physical examination should be insisted upon and the co-operation of the patient's general practitioner sought in order that nothing is overlooked. Operation should not take place during the menstrual period. Patients in poor general condition and particularly those of asthenic habits with bad skins should be avoided or given an opportunity of putting themselves in the best possible condition. One should eliminate those who might be

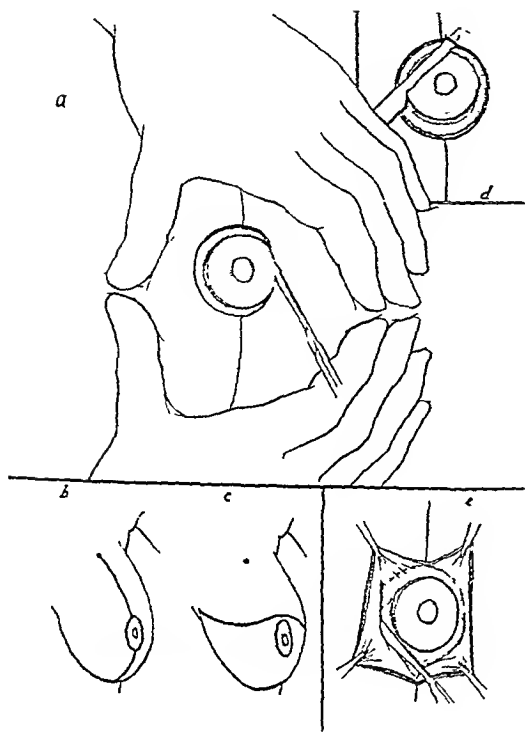


Fig 3 a, Even and firm stretching of nipples by assistant, circumcision of areola b, Double upper flap method c, Single upper flap method d, Superficial undercutting of skin surrounding areola, thus avoiding injury to subareolar plexus of vessels e, Application of four forceps at indicated points Extension of undermining at deeper level

from the new nipple position to the top of the areola, and from the bottom of the areola downward to the submammary groove. It is better to mark out on both sides with Bonney's blue all proposed incisions before the skin is actually cut in order that no mistakes be made in the symmetrical placing of the breasts. These markings, however, must be used rather as an initial than as a final guide, for minor alteration may be necessary when the skin flaps are eventually adjusted to fit the breast tissue (Fig 2).

**Operative details** The areolæ are now circumcised superficially and the skin undermined for a distance of half an inch laterally without damage to the subareolar plexus of veins. The vertical or transverse line is opened and preparations are made for the separation of the breast tissue from its skin covering. Formerly this was carried out by undercutting with a knife, a procedure associated with considerable blood loss and much shock to the patient. It has been supplanted by an almost bloodless method which can be rapidly

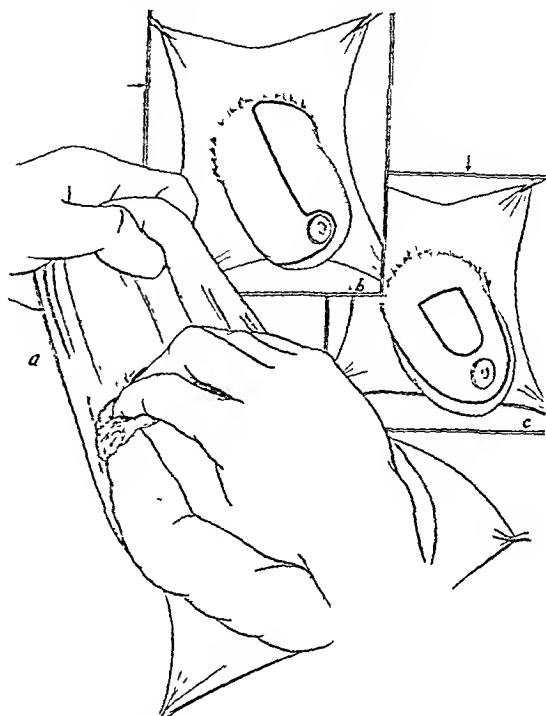


Fig 4 a, Separation of breast tissue from skin by stripping with gauze b, Incision line for formation of internal pedicle c, Incision lines for double breast pedicle

performed. After the preliminary periareolar undercutting has been done, the gland is separated from the skin by blunt dissection with gauze held in the fingers almost in the same way as one would skin a rabbit. It will be found that the breast shells out with ease and with a minimum of bleeding, thus leaving the important subcutaneous plexus of vessels attached to the skin. The few bleeding points are secured and tied (Figs 3 and 4).

**The formation of the breast pedicle** The internal breast pedicle is made by an S shaped incision which begins along the lower border of the second rib, sweeps down vertically at the level of the inner border of the areola, turns laterally to skirt the nipple, and is carried off medially to the end of the pendulous breast. The double pedicle is made by the removal of a V shaped portion of the upper middle segment of the breast followed by complete mobilization of the inner and outer pedicles which are reduced in size to form a U shaped tube of breast tissue carrying the nipple at the apex of the U. In the case of the single internal pedicle, it is rotated upon itself laterally until the nipple corresponds to the position as marked on the skin,

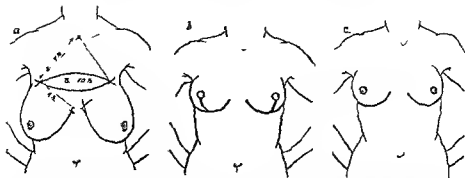


Fig. 2 a Determination of new nipple position by intersecting circles using the suprasternal and axillary notches as centers. Radii vary with body habitus but are within limits indicated. b and c Position of scars after operation. b after double flap operation. c after single flap operation. In both cases nipples look forward and outward.

cally disappeared so that the lateral flap method which does not require a secondary operation so frequently is becoming more popular. There are two absolute indications for its use: (a) In moderate degrees of ptosis when the upper flap is so short that the new position of the nipple is too close to the submammary incision; (b) when the submammary incision would otherwise be too long and reach into the axilla.

**Anesthesia.** Light general anesthesia—gas and oxygen superimposed on preliminary avertin or evipan—is used routinely, as little ether being used as possible. If this is given through a nasal intratracheal tube the draping of the operation field is greatly facilitated and the proximity of the anesthesiologist to the operative field dispensed with.

**Position on the table.** It is an advantage to use an operating table which breaks in the center so that the two ends can be elevated to give a semi-sitting position with the patient's chest at an angle of 45 degrees to the horizontal. Thus the breasts fall into their normal dependent position and the measurements for the position of the nipples can be more carefully made. With the anesthesiologist supporting the head and a nurse pulling forward on each arm the anesthetized patient is drawn up into full sitting position and the skin of the entire chest and upper back again sterilized. She is then laid squarely back on a sterile sheet placed beneath her, care being taken to see that the shoulders are level. The arms are then placed akimbo with the hands behind the hips. The anterior surface of the chest is towelled off from the sternal notch above to the upper abdomen below, and laterally, excluding the axillae and arms. If this is done symmetrically the accurate placing of the breasts will not be confused by extraneous irregularities (Fig. 1).

**Measurements for the nipple positions and marking of incision lines.** A great number of methods have been described for the accurate placing of the nipples. Some of them are complicated and difficult to apply. While it is true that an appreciation of the classic form is probably helpful in deciding this point, some form of accurate measurement should be made to avoid mistakes in the level of the breasts and the internipple distance, for an error of half an inch becomes painfully apparent at a later date. Unquestionably the patient's general configuration, size and body habitus must be taken into account. Assuming that the levels are correct, the commonest mistake is to get the nipples and breasts too close together. We have found a large compass of great aid in calculating the new nipple position. Using the sternal notch as the center a circle is drawn with a radius varying between 6 to  $7\frac{1}{2}$  inches depending upon the height and shoulder width of the patient. This is intersected by a second circle on the axillary notch as center with a radius half an inch less than the previous circle. The intersection of the two circles gives the approximate position of the nipples. The internipple distance should rarely be less than 9 inches and minor corrections can be made according to the judgment of the surgeon. The new position for the nipple is then marked by stabbing the skin with Bonney's blue. The assistant then stretches the areola tightly and evenly with two hands and a  $1\frac{1}{4}$  inch circle is drawn round them with a smaller compass. This particular measurement varying in accordance with the wishes of the patient. If the single upper flap method is to be used a transverse line with its convexity upward is marked out from the lower end of the submammary groove. If the second method is to be utilized a vertical line is made

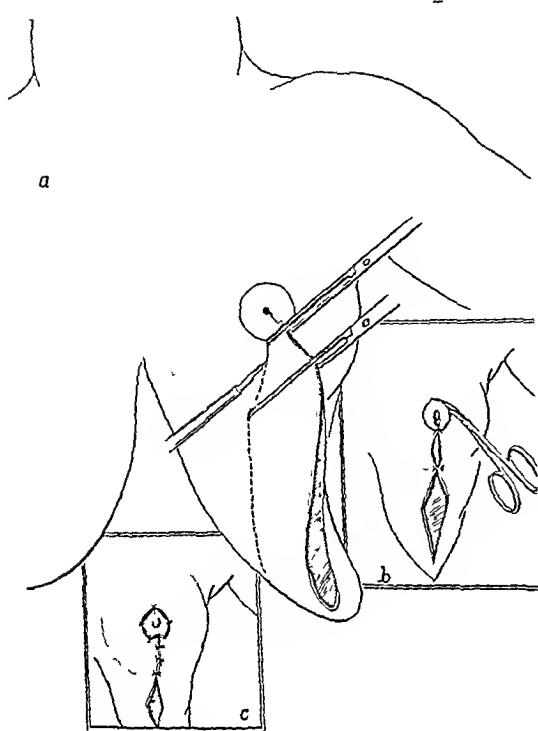


Fig 7 Double upper flap method a, Skin flaps held with forceps fitted round cone of breast tissue Marking of excision line b, Removal of excess skin to form double upper flap Insertion of upper and lower sutures Cutting off apex of cone to expose nipple c, Suture of nipple and vertical scar

gauze dressing is then applied with mastisol fixation, and this covered with wool and bandage

*Possible second stage operation* Three to 4 months after the first operation the condition is reviewed and careful note made of any irregularities of contour or scars The latter can be excised and sufficient skin lifted to enable redundant areas of breast tissue to be removed At the same time the transverse submammary scars can be placed accurately in the submammary groove, and the closure effected by means of subcuticular sutures As a rule no drainage is required at this operation As a preventative against the development of keloid scars a dose of x-rays may be given one week before and one week after this operation

#### POSTOPERATIVE CARE

It must not be forgotten that some of the factors which produce shock are present, loss of body heat, extensive tissue exposure, and loss of body fluid. In our clinic the patient is transferred from the operating table into a warm bed brought into

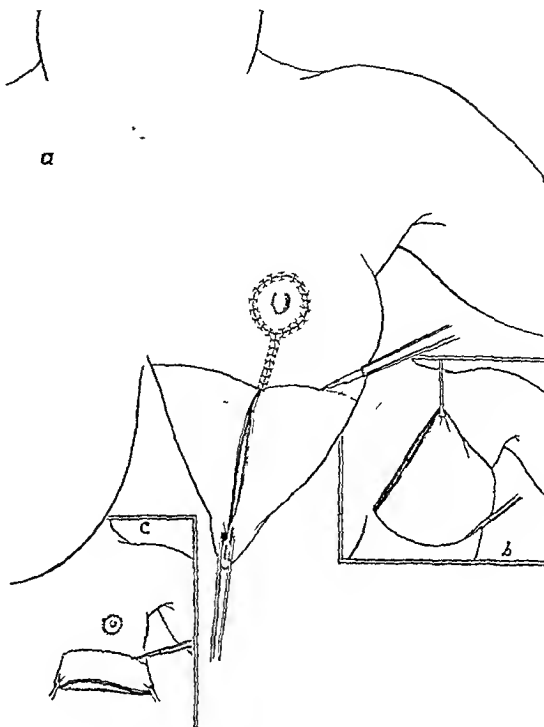


Fig 8 a, Dependent excess of skin drawn downward and marked for excision b, Excess turned upward and completion of marking in submammary groove c, The same process is carried out in the single upper flap method

the theater at the end of the operation No further lifting or disturbance is necessary for some hours Postoperative rectal fluid is always given as a routine and consists of hot tap water given by the drip method Sedative drugs can be given as indicated As soon as the patient is fully conscious she may be raised from the prone to a sitting position. The first dressing should be done at the end of 48 hours, when if indicated the tubes may be removed Routine cleansing of the whole area with saline and subsequent drying with spirit is all that is required Stitches must be removed in a good light with toothless forceps and fine sharp pointed scissors The alternate sutures round the nipple may be removed on the fourth day, and on the fifth day the remainder may come out together with a few from the main scars All the stitches from the latter should be out by the tenth day, the last being those bearing tension at the corners of the flaps Subcuticular stitches will also come out easily by this time, but must be left longer if they will not slip out painlessly. After final removal of stitches application of a little sterile paraffin will soften and cleanse the scars



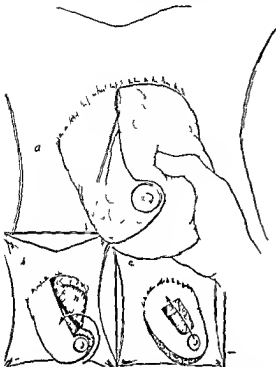


Fig 5 a Formation of internal pedicle of left breast. Deep incision to expose pectoral fascia. Hand holds part to be removed. b Internal pedicle complete. Rotation indicated. c Formation of double pedicle following removal of upper central portion of breast tissue.

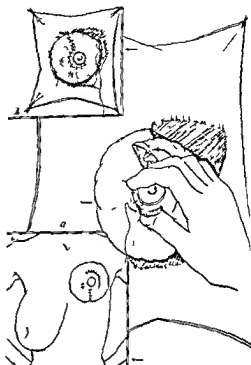


Fig 6 a Rotation of pedicle and correct placing of nipple. b, Fixation of breast cone to pectoral fascia. Infolding sutures inserted to bring nipple forward. c Method of suture for double pedicle.

the tail being secured to the pectoral fascia at the level of the second rib. By judicious placing of plain catgut sutures it is then built up into a cone pointing forward and outward with the nipple on its apex. The cone should not be dragged or pulled in such a way that interference with the blood supply occurs. In the case of double pedicles these are folded in W form to produce the desired contour of the breast. In both cases the base of the cone is fixed to the pectoral fascia and muscle by a series of interrupted catgut sutures (Figs 4, 5, 6).

**Treatment of the skin flaps.** The upper skin flap is brought down over the breast cone and sufficient of the submammary skin is excised to allow of easy approximation of the edges to form a single transverse submammary scar. As a rule the upper flap is larger than the lower and should be "fanned in" with interrupted sutures to make it as short as possible. A fine hook is then inserted into the marked position of the new nipple on the upper flap. A cone of skin is lifted and cut off with sharp scissors. This will give a perfect circle and

the nipple itself will be found lying beneath. It is then extruded and sutured to the skin edge with finest silk. In the formation of lateral flaps the entire excess of skin is drawn together and downward and a series of Allis forceps are applied from the marked position of the new nipple to the submammary groove. These are adjusted in such a way that the skin fits comfortably over the cone of breast tissue, the slack being taken up in the grip of the forceps. The amount of tension is not so great as to interfere with the blood supply of the flaps. The excess skin is cut away vertically as a  $\Lambda$  and this suture line is completed. A circle is then drawn round the marked position of the nipple incised and the nipple extruded and sutured with fine silk as before. The transverse excess is then trimmed in the submammary region, closure being effected with fine interrupted silk sutures (Figs 7, 8, 9). If there is any excess of skin at the ends of the transverse incisions these are treated by the usual triangular excision (Fig 9 d e f). A small tube should be inserted at each end of the incisions and fixed with a suture. Dry

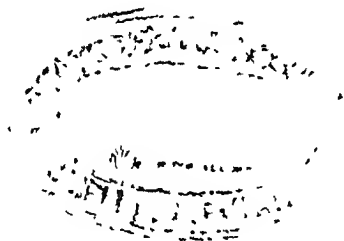
skin The abscess should be opened and drained Within a few days the necrotic portion of the pedicle can usually be seen and as much as possible cut away with scissors through the small opening necessary to drain it Eusol irrigation will aid the removal of necrotic material

#### GENERAL PROGNOSIS

The relief of intertrigo and the feeling of weight is immediate The latter in due course leads to improvement in posture especially in young girls. From the psychological point of view the patient finds herself able to go among her friends with a new-found equanimity Those girls who feared married life with a sensitiveness amounting almost to melancholia regain their self-confidence Nipple sensation becomes fully established in 70 per

cent of cases, and erectile innervation is preserved in all cases. Anatomically lactation should take place as some of the parenchyma with its ducts is left attached to the nipple, but it is doubtful whether it would be entirely satisfactory It must be remembered that an unoperated upon hypertrophied breast is not usually a satisfactory milk-producing organ. Data on the subject of postoperative lactation are not yet sufficient as in experience many of our patients are unwilling to institute breast feeding being overwhelmed by the quite unfounded fear that hypertrophy may recur.

In conclusion there would appear to be no question as to the satisfactory end-results of this operation provided that all the precautions enumerated are carried out



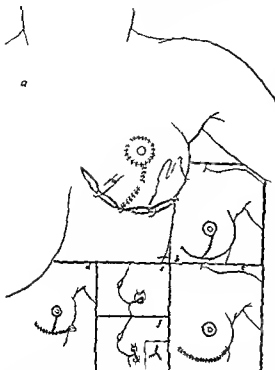


Fig. 9. a Closure of submammary incision with interrupted fine silk sutures. b Suture completed double upper flap method. c Suture completed single upper flap method. Upper flap is fanned into shorter lower one. d e f Method of dealing with excess skin at ends of incision without increasing total length of scar.

As regards convalescence many of these patients tend to overtax their strength too soon after operation. They feel their friends expect them to resume their social activities as soon as they leave the hospital on the fourteenth day and consequently they are apt to suffer from a marked nervous reaction to what must of necessity have been a profound physiological and psychological disturbance. This can easily be avoided by a short period of convalescence in the country or preferably at the seaside. This gives an opportunity for nerve recovery and stimulates healing, softening of the skin flaps, and absorption of bruising. Arm exercises may be commenced during this time but vigorous movements should not take place until at least 4 to 6 weeks have elapsed following the operation.

#### POSSIBLE COMPLICATIONS

Possible complications which may follow operation are (1) hemorrhage, (2) sepsis, (3) partial necrosis of skin flaps or pedicles.

Hemorrhage of slight reactionary type is coincident with recovery from the anesthetic, but if the tubes have been inserted as described will give rise to no disturbance. Secondary hemorrhage is uncommon and may produce external bleeding, or more possibly a concealed hematoma which is revealed in time by severe bruising, loss of contour, and interference with circulation. The treatment is to evacuate the hematoma with all aseptic precautions as there is a liability to infection.

Sepsis may be evidenced by mild local stitch infection. Here variation of treatment is the keynote of success. The removal of the infected stitch may be followed by dressings with eusol, hypotonic saline, or glycerine and magnesium sulphate paste. The aim is to establish mild antiseptics without damage to tissues. If the patient is strong enough immersion in a warm saline bath is satisfactory so long as the whole breast area is carefully dried with spirit subsequently. Infection of a hematoma requires thorough opening and drainage as soon as the diagnosis is made, a sinus forceps being passed through one of the incision lines into the collection and followed by a tube which is left *in situ* until drainage ceases. Generalized sepsis is very rare in our experience and is evidenced by rapid rise in temperature and pulse with signs of diffuse local inflammation. In the only case in which it occurred the breast was thrown open immediately and Carrel-Dakin treatment instituted with satisfactory results. Should the incision lines be opened for this or any other reason they should be left to heal of their own accord. It is a good rule in plastic surgery to avoid secondary suture wherever possible.

Partial necrosis of skin flaps is an annoying complication inasmuch as healing will be considerably retarded. Discoloration of the affected portion rapidly occurs and in a day or two the line of demarcation is established. In the case of single upper flaps it is the lower edge and in the case of lateral flaps the medial and lower corners. Occasionally the applications of warm saline every 15 minutes will prevent more than a very superficial loss, but if the necrosis is more extensive it should be encouraged to separate as soon as possible in order that epithelization may proceed. The skin loss is rarely more than one square inch, and as a rule is not worth grafting. A simple dressing of tulle gras renewed daily after a warm bath will effect rapid improvement. If the scarring resulting from the skin loss is unpleasant it is best removed at the second stage operation.

Necrosis of a portion of the pedicle will be evidenced by an abscess pointing underneath the

Wm P Didusch 1931

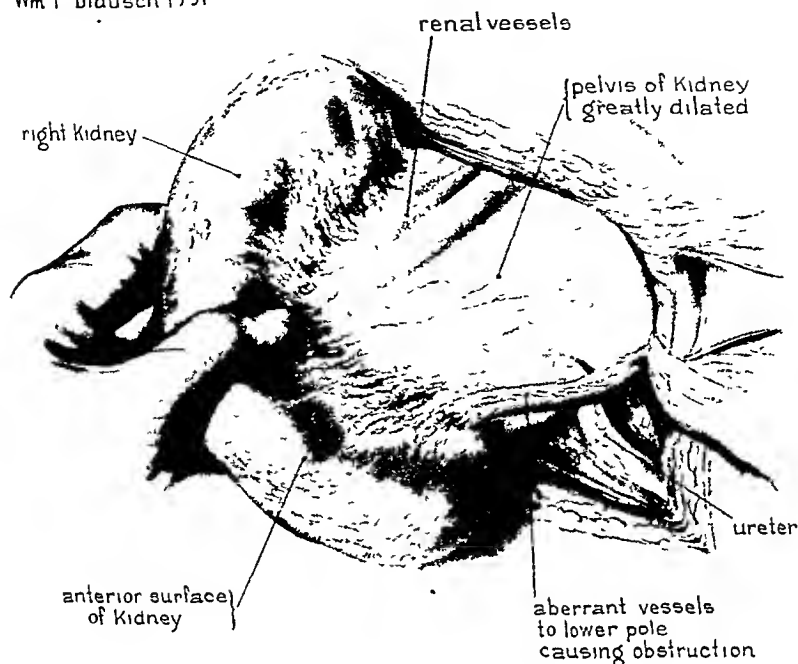


Fig 1 Anterior surface of right kidney which has been delivered through wound, showing accessory vessels at lower pole, which caused pressure, kinking, and obstruction to ureter. No stricture was found on external or internal examination. Vessels were too large to divide. Plastic on pelvis designed to eliminate obstructive contact. The postoperative result is shown in Figure 4. B U I 19905

and junction, serving to draw these structures away from the vessels. In 3 of these it was of the Y-plasty type, and in 1, the Heineke-Mikulicz. In 2 cases the vessels were divided and a Y-plasty made on the junction. In the seventh case, the vessels were divided and a thorough dilatation of the stricture with bougies was carried out. The eighth patient (B U I 25859) a child of 2½ years, was not thought at the time of operation to have a stricture. The vessels were divided and the kidney was suspended, but 2 years later a urogram showed a conspicuous narrowing at the

ureteropelvic junction with no appreciable decrease in the size of calyces or pelvis. Apparently the stricture was unrecognized because of the small size of the structures.

A comparison of these 2 groups of cases reveals several interesting facts. In Group A, the average age of onset was 24 years, and in Group B, 13 years (Table I). When the symptoms first appeared, the majority of patients in Group A were over 16 years, and in Group B, one half were under 10 years.

TABLE I—COMPARISON OF AGE INCIDENCE

Age at onset in years	Group A Accessory vessels without stricture	Group B Accessory vessels with stricture
1 to 5	None	3
6 to 10	2	1*
11 to 15	None	1
16 to 20	5	1
21 to 25	None	1
over 25	4	1

\*This case (B U I 26210) had symptoms referable only to one kidney, but both were found by excretion urography to be hydronephrotic.

TABLE II—COMPARISON OF DURATION OF SYMPTOMS

Duration of symptoms	Group A Accessory vessels without stricture	Group B Accessory vessels with stricture
Less than 1 month	1	1
1 to 3 months	2	1
4 to 8 months	None	1
9 to 11 months	None	None
1 to 3 years	3	4
Over 3 years	5	None

73 per cent of patients in Group A had symptoms for 1 year or longer, and in Group B, 43 per cent for 8 months or less.

## ACCESSORY RENAL VESSELS

### Their Influence in Certain Cases of Hydronephrosis

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**A**LTHOUGH nearly 100 years have elapsed since Rayer first pointed out the causal relationship of anomalous renal arteries to hydronephrosis, there is still no unanimity of opinion among urologists upon this subject. There are, essentially, three divergent views concerning the principal factor in the causation of obstruction at the ureteropelvic junction associated with accessory vessels at the lower pole of the kidney. The first is that the vessel, probably as the result of some change in its relationship to the ureter or pelvis, is itself the most important single cause. The influence of ptosis in producing such an altered relationship is a matter of some dispute and will be considered in detail later. The second is that a stricture at the junction, or somewhere along the course of the ureter, perhaps overlooked in the urogram, initiates a dilatation and, as this progresses, the pelvis, becoming increasingly heavy with retained urine, sags over a vessel which originally caused no obstruction. The third view is that a disturbance of the neuromuscular mechanism of the renal pelvis results in such diminished peristaltic activity that the contained urine cannot be expelled through the ureteropelvic junction.

I am greatly indebted to Dr. Hugh H. Young for permission to study the 70 cases of hydronephrosis in the records of the Brady Urological Institute in which dilatation commenced in the region of the ureteropelvic junction, caused by mechanical obstruction at this level as proved at operation. Thirty of these (42.9 per cent) uncomplicated by renal calculi, were found to be associated with accessory vessels at the lower pole of the kidney. An analysis of these cases was undertaken in an attempt, first, to clarify the different concepts of the etiological or precipitating factors, and, second, to reveal what features influence the ultimate postoperative result. No attempt has been made in this paper to evaluate the merits of the various plastic operations for stricture at the ureteropelvic junction.

These 30 cases, for the purpose of convenience have been grouped as follows:

#### I. Conservative surgical procedures 19 cases

From the James Buchanan Brady Urological Institute, Johns Hopkins Hospital, Baltimore, Maryland

(A) Accessory renal vessels, the only demonstrable cause of obstruction 11 cases, (B) Accessory renal vessels associated with stricture at the ureteropelvic junction, 8 cases

II Nephrectomy, 11 cases (C) Accessory renal vessels the only demonstrable cause of obstruction, 9 cases (D) Accessory renal vessels associated with stricture at the ureteropelvic junction, 2 cases

#### II. CONSERVATIVE SURGICAL PROCEDURES

*Group A. Accessory renal vessels the only demonstrable cause of obstruction, 11 cases.* There were 6 instances in which complete relief of the obstruction was afforded by simple ligation and division of the vessels as was evidenced by the prompt emptying of the distended pelvis. In the 5 remaining cases, the pelvis was opened and the ureteropelvic junction was explored before excluding the presence of stricture. In 2 of these the vessels were merely ligated and divided. In the 3 remaining, the vessels because of their large size were not divided, and the obstruction was relieved in 1 case by reimplantation of the ureter and in the 2 others by the resecting portions of the pelvic walls and closure in such a way as to eliminate contact between the ureter and vessels. The technique described by Young was employed (Fig. 1). The ureteropelvic junction itself was of normal caliber, and consequently was not subjected to plastic operation. Pre-operative and post-operative urograms have been obtained in 9 of the 10 cases in which the ureter was not operated upon (Figs. 2 to 10). These results, obtained by simple removal of the contact between vessels and ureter, either by division or by drawing the ureter away from the vessels show that such contact was in itself productive of obstruction.

*Group B. Accessory renal vessels associated with stricture at the ureteropelvic junction 8 cases.* The presence of stricture was recognized at operation by a definite narrowing of the upper end of the ureter through which the pelvic contents would not readily escape after elimination of the contact between vessels and ureter (Fig. 11). In 4 instances the vessels were of large size and therefore not disturbed. Obstruction was eliminated in these cases by a plastic operation on the pelvis



Fig 6 a, left Pre-operative intravenous urogram in a 21 year old man having had attacks of pain in right flank for 1 year. Lower group of calyces and pelvis markedly dilated and not visualized for 2 hours. Urine sterile. b, Retrograde pyelogram 1 year, 4 months after ligation and division of accessory vessels, showing decrease in size of calyces and pelvis, and a patent ureteropelvic junction. No postoperative functional studies were made. Symptoms completely relieved. B U I 24752

## II NEPHRECTOMY

Groups C and D, comprising 11 cases in which nephrectomy was carried out, will be considered together because they resemble each other in nearly all respects. The average age of onset was 33 years, 6 months. The average duration of symptoms was 5 years, 6 months. This coincides with the history obtained from the patients in Group A and suggests that some factor, besides that of duration, causes the condition requiring nephrectomy.

In this group of 11 cases, the kidneys in 6 were hardly more than shells. One kidney was smaller but functionless, another was the seat of a severe chronic pyelitis, and two showed acute and chronic pyelonephritis with abscesses. In the sixth case (B U I 22083) the kidney was removed because of accidental trauma during exposure. Its cortex was very thin and was torn during manipulation. The reasons for nephrectomy were (1) functionless kidney, 7 cases (64 per cent), (2) severe infection, 3 cases (27 per cent); (3) accidental trauma, 1 case. The chief factors responsible for the condition necessitating nephrectomy seem to be (1) completeness of obstruction, acting for a variable length of time, and (2) severity of infection.

### UNDERLYING CAUSES OF OBSTRUCTION

*The mechanical basis.* A careful study has been made of Groups A and C, totalling 20 cases, in which the vessels were the apparent cause of obstruction, and this shows that there is much room

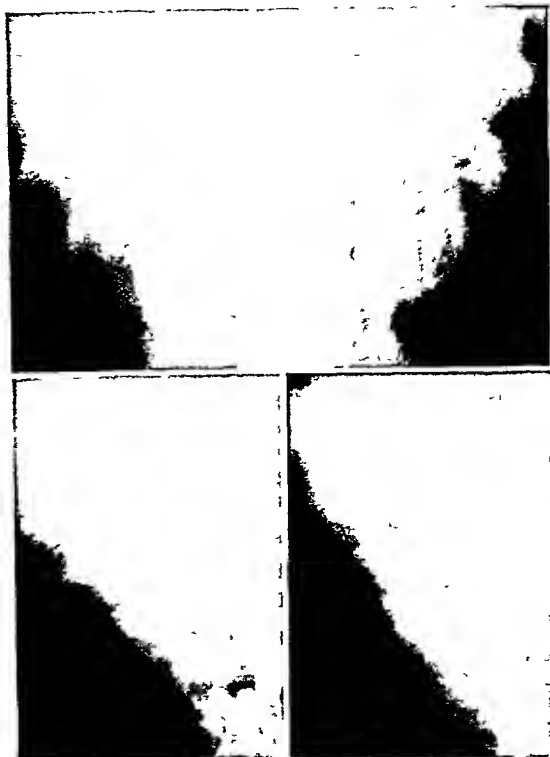


Fig 7 a, left Pre-operative intravenous urogram in a 37 year old man who had had episodes of pain in right flank for 10 years. There was no excretion of medium by the right kidney in 35 minutes, which is represented by a large mass in the film. Urine was sterile. b, Intravenous urogram 3 weeks after resection of large extrarenal pelvis to eliminate contact between ureter and accessory vessels. c, Intravenous urogram 2 years later, showing marked reduction in size of calyces and pelvis, and upper ureter well filled. There was marked improvement in function, and symptoms completely relieved. B U I 24390

for speculation concerning the nature of the precipitating factor in the causation of the hydronephrosis. In our series the condition is chiefly one of early adult life. The accessory vessels, however, had been present ever since the kidney reached its definitive position in the embryo, but had not caused obstruction until this relatively late date. One, therefore, must conclude that some additional factor appeared at this time and altered the innocent relationship between ureter and vessels. This concept is given further emphasis by the well known fact that accessory renal vessels at the lower pole are sometimes encountered when no obstruction exists. That this factor varies in different patients is at once apparent from a study of the cases in this series and of the literature.



Fig. 3 a left Pre operative retrograde pyelogram in a 19 year old boy who had had attacks of right abdominal pain for 7 weeks. Function was somewhat impaired but urine was sterile. b Intravenous urogram 7 months after division of accessory vessel showing marked reduction in size of calyces and pelvis. The function was normal and symptoms completely relieved. BUI 2,380

The average duration of symptoms in Group A was 5 years, and in Group B 1 year, 6 months (Table II). Although it is always hazardous to draw conclusions from statistics based on a small series of cases, the discrepancies between these two groups are striking. The duration of the symptoms in those patients without strictures was nearly 4 times as long as that in the group with strictures. If such strictures are caused by the trauma resulting from long continued contact between vessels and ureter, one would expect them to have occurred in the older group of patients



Fig. 4 a left Pre operative left pyelogram in a 19 year old boy with bilateral hydronephrosis and uremia. There was no history of pain. Urine sterile. b Pyelogram 5 1/2 years after ligation and division of accessory vessels showing considerable reduction in size of pelvis and calyces. There was marked functional improvement in this patient. BUI 19005

with symptoms for a longer period. That strictures at the ureteropelvic junction without associated vessels are not infrequently encountered adds additional evidence to support the contention that the stricture may be a primary pathological entity.

Of the 11 cases in Group A only 3 kidneys were found infected on admission and of the 8 in Group B, only 2 were infected. None of the other patients gave even a previous history of pyuria or vesical irritation. The etiological relationship, therefore, between urinary tract infection and stricture, in this series at least, is not established.



Fig. 4 a left Pre operative right pyelogram in same case as Figure 3. Urine badly infected. Pelvis drained by indwelling ureteral catheter for several weeks and no phthalein appeared for 11 days. After that it increased rapidly. b Pyelogram about 5 1/2 years after resection of large portion of pelvis eliminating contact between accessory vessels and ureter. Improvement in renal function was marked but residual infection was considerable.



Fig. 5 a left Pre operative pyelogram showing markedly dilated pelvis and calyces in a 62 year old man who had had episodes of renal colic for 20 years. Function as determined by excretory urography was practically normal and urine sterile. b Pyelogram 2 years after ligation and division of accessory vessels showing marked shrinkage in size of calyces and pelvis. Symptoms completely relieved. BUI 22314

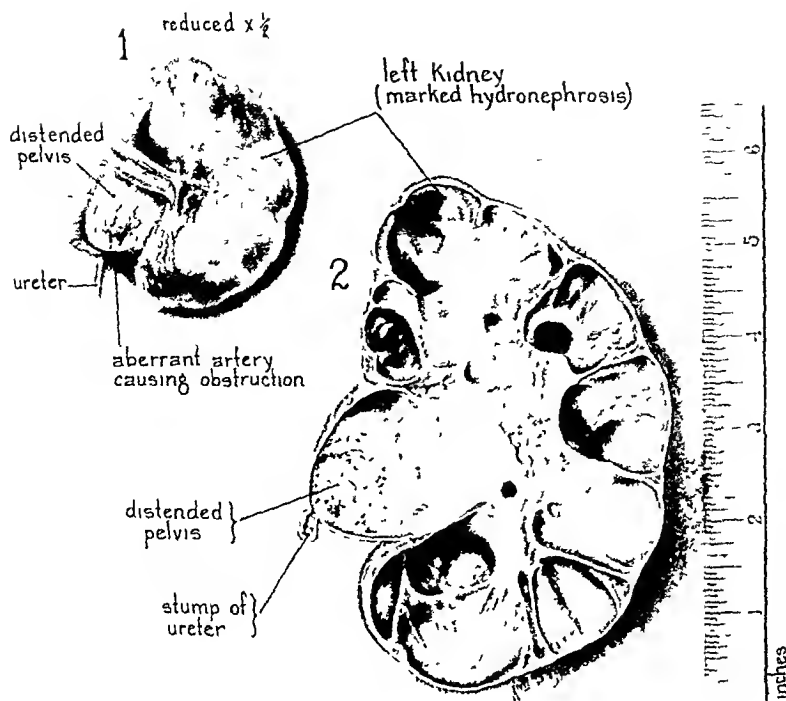


Fig 11 1, Dilated pelvis sagging over accessory artery to lower pole of kidney 2, Sectional view showing stricture at ureteropelvic junction Complete destruction of kidney requiring nephrectomy, although pelvis only moderately distended Patient aged 5 years B U I 22466

It has been suggested that over-rotation and under-rotation of the kidney about its vertical axis may serve in some cases to allow the ureter to press upon the vessels sufficiently to cause obstruction to the free flow of urine. In 4 of our 20 cases, not associated with stricture, such rotation was present, but no mention was made of its direction. It is evident that under-rotation would be of significance only if the vessel passed in front of the ureter, and over-rotation only if the vessel passed behind.

According to Sanford, Liek believed that the lower polar vessel may not grow as rapidly as the renal pedicle, and it is conceivable that such a disproportionate rate of growth might result in contact between vessel and ureter. In 2 of our 20 cases without stricture, the vessels were described as being taut. In only one, however, was the longitudinal axis of the kidney perpendicular instead of inclining towards the midline above the kidney. Since ptosis was absent, thereby elimi-

nating the possibility of pendulum rotation, the change in the vertical axis may have been caused during development by traction exerted by the vessel upon the lower pole of the kidney.

After a consideration of all these theories regarding the basic cause of the obstruction, it would seem that the most plausible explanation lies in the fact that the kidney undergoes a remarkable change in shape during its growth to adult size. Kelly and Burnam showed that in the infant the kidney is arched upon itself to such an extent that the 2 poles approach each other very closely over the enclosed pelvis (Fig 12). In the adult the poles have diverged markedly from each other, and by this straightening process the pelvis has become largely extrarenal. As is well known, the pelvis usually presents on the posteromesial aspect of the kidney, but it sometimes lies on the anteromesial aspect. Therefore, it would seem possible that in certain cases an accessory vessel attached to the lower pole could be carried





Fig 8 a left Pre-operative retrograde pyelogram showing moderately dilated calyces and pelvis. In a 41 year old married woman had had pain in the left flank and vesical irritability for 10 years. The function was normal and the urine was sterile on admission. b Intravenous urogram 3 weeks after simple ligation and division of an accessory vessel showing diminution in the size of the calyces and pelvis and a patent ureter. Symptoms were completely relieved. BUI 24922

Ptosis has long been held the underlying cause of obstruction in cases of this sort, and it is true that in the majority some descensus of the kidney can be demonstrated. In 4 of our 30 cases however the presence of ptosis was denied. Blanc and Bourland also stated that it was absent in 3 of their cases and Winsbury White and others assert that renal mobility *per se* is a very doubtful cause of hydronephrosis. In the last 250 cases of

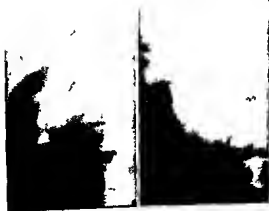


Fig 10 a left Pre-operative pyelogram showing moderate dilatation of pelvis and calyces in a 24 year old man with only pyuria for 4 years. b Pyelogram 16 years after simple ligation and division of accessory vein showing diminution in the dilatation. There was marked functional improvement and disappearance of the infection. BUI 4632



Fig 9 a left Pre-operative pyelogram in a boy aged 18 having had 4 attacks of pain in flank beginning 3 years previously. Renal function was considerably impaired, urine sterile. b Intravenous urogram 7 1/2 years after ligation and division of accessory vessel. Function now normal and symptoms completely relieved. BUI 1935

hydronephrosis of all types operated upon in the Brady Urological Institute not one could be attributed to ptosis alone. Furthermore ptosed kidneys with accessory vessels at the lower pole without hydronephrosis are not infrequently observed. The distal attachment of the vessel runs downward with the kidney, so some other factor must be present in most cases at least to bring about the necessary fixation of the ureter. Fleckhorn from a study of 24 cases collected from the literature, to which he added one of his own made the interesting observation that vessels pursuing a diagonal course running across the ureter either anteriorly to pass beneath the ureter or the posterior aspect of the hilum or lower pole, or vice versa were the ones much more apt to cause obstruction. Foley recently has emphasized this point. In 6 of the cases reported by Fleckhorn, in which the diagonal course of the accessory vessel was clearly described 4 crossed behind the ureter. In none of our cases was any note made of vessel running in such a manner as Fleckhorn described.

Foley has stressed the importance of horizontal axial rotation of the kidney or a forward pitching of the upper pole in bringing about contact between ureter and vessels. According to him this condition can be diagnosed from the pyelogram by the presence of a shortened longitudinal axis together with the closing of the angles between the calyces. In one of our cases this condition was observed (BUI 26210).

Quimby believes that the accessory renal artery through constant pulsation against the wall of the pelvis or ureter, finally interrupts the peristaltic waves and produces pelvic dilatation. In 2 of our cases the only vessel present was a vein

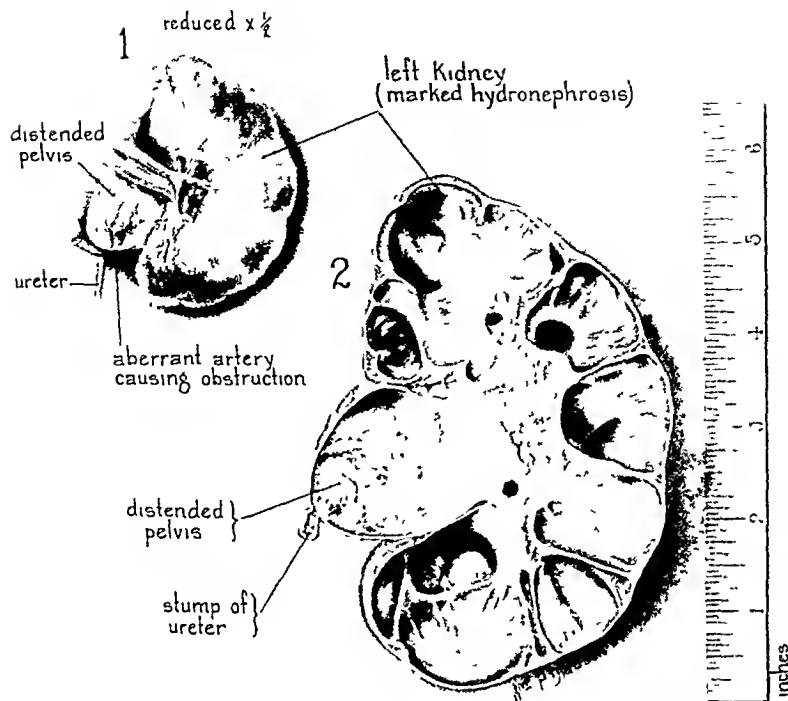


Fig 11 1, Dilated pelvis sagging over accessory artery to lower pole of kidney 2, Sectional view showing structure at ureteropelvic junction Complete destruction of kidney requiring nephrectomy, although pelvis only moderately distended Patient aged 5 years B U I 22466

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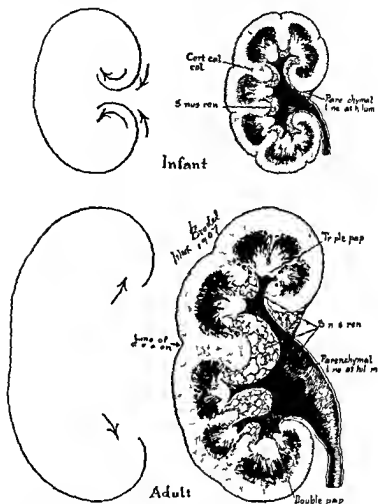


Fig. 12 The divergence of the two poles in the adult kidney is clearly shown. This process enlarges the hilum and pushes the pelvis outside. An accessory lower polar vessel may be carried downward and outward across the external pelvis (From Kelly and Burnam)

downward and outward across the pelvis which has been extruded in such a way as to press upon this vessel sufficiently to cause obstruction. Although all kidneys with accessory vessels are not hydronephrotic almost all those in which obstruction exists have extrarenal pelvis. Therefore, a variability in the factor of growth could explain the inconstancy both of the obstruction and within certain limits of the age at which it occurs.

From the foregoing it is evident that many different factors have been considered responsible for setting into motion the mechanism of obstruction. In certain cases, 33 per cent of our series

a definite stricture is present and, as dilatation progresses the effect of an accessory vessel may be of only secondary importance. But in others, no such stricture can be found and the accessory vessels assume the leading rôle although thrust into prominence by the operation of one or more subsidiary and variable forces.

**The neuromuscular basis.** Recently many articles have appeared in the literature regarding the neuromuscular mechanism of the pelvis and ureter. Some authors state that a disturbance of pelvic peristaltic activity is the primary factor in the production of the hydronephrosis and the importance of an associated vessel is more ap-

parent than real. In order to understand this neuromuscular mechanism one must consider both its extrinsic and intrinsic components.

The extrinsic components can be interrupted by a careful denervation of the renal pedicle. Extensive literature exists on this subject, and sympathectomy has been recommended for pelvic atony, or adynamia, as well as for hyperdynamic motility. Most of these operations, however, are carried out simply for the relief of pain. Occasional cases of pyelectasis, as described by Braasch, have been reported in which marked hypertonicity of the musculature of the pelvis and ureter apparently gave rise to obstruction at the ureteropelvic junction through spasm. Periarterial sympathectomy is thought by some surgeons to be of value here, although Allemann prefers a longitudinal incision through the pyeloureteral sphincter down to the mucosa. It is possible that a dysfunction of the extrinsic nerves is responsible for such dynamic obstructions, but, aside from these rare instances, it is generally agreed, according to Hinman, that no persistent anatomical change occurs after sympathectomy.

As regards the intrinsic components, little is known. The fact that pelvic and ureteral peristalsis is retained after denervation of renal pedicle and ureter proves the existence of an intrinsic mechanism of the pelvis and ureter. Moreover, the persistence of peristaltic activity for a time after nephro-ureterectomy also indicates that peristalsis is not entirely dependent upon the extrinsic nerve supply. It is conceivable that if some disturbance of this intrinsic mechanism actually occurred, it might result in such diminished peristaltic activity that the pelvis would be unable to expel its contents into an unobstructed ureter. Such



Fig 13 Rabbit's kidney showing intrarenal pelvis and close proximity of two poles to each other, somewhat resembling the condition in the infant (See Fig 12.)

a condition, obviously, would lead to hydronephrosis. There are a few alleged cases of this sort on record, but none is acceptable unless meticulous care has been exercised to exclude a mechanical obstruction. In many instances the presence of angulation and slight fixation of the ureter may not be apparent after operative delivery of the kidney, for such manipulation may free adhesions and change the relationships which existed *in situ*. In some cases, a small stone passed unnoticed before admission to the hospital is the true but undetected cause of the hydronephrosis. In the 70 cases from which the material for this paper was gathered, a mechanical obstruction responsible for the hydronephrosis was identified in every instance. An adynamic pyelectasis, therefore, must be rare.

The hydropelvis resulting from alleged vascular obstruction in the region of the ureteropelvic junction in the typical case is at first pyriform, as described by Braasch. It is also predominantly



Fig 14, left Pyelogram showing an intrarenal hydronephrosis. At operation obstruction was found to be caused by accessory lower polar vessels. B U I 25427

Fig 15 a, center Intravenous urogram of normal extrarenal pelvis. b, Same kidney 3 months later, showing hydronephrosis, predominantly pelvic in type, resulting from an infiltrating tumor of the bladder, obstructing the intramural ureter. The rounded contour of the pelvis is conspicuous. No operation. B U I 25058

Fig. 16  
173



Fig. 16 Hydroureter and hydronephrosis resulting from a ureteral stricture. Renal parenchyma shows very little compression and dilatation is almost entirely pyelo-ureteral. Pelvis is extrarenal and grossly funnel shaped with widely divergent renal poles. BU 14114 (See Fig. 12)

extrarenal and later exhibits a globular appearance in the pyelogram. It therefore differs markedly from the intrarenal hydronephrosis caused by high or low ureteral obstructions in experimental animals. The globular form appears very different also from the grossly funnel-shaped pelvis seen in patients with an obstruction involving the lower ureter. These observations led Horsford to conclude that such an extrarenal, globular

dilatation must be attributed to a disturbance of the neuromuscular mechanism of the renal pelvis.

We believe that factors other than primary neuromuscular derangements are sufficient to explain the variations encountered. In the first place there is considerable evidence to support the contention advanced by Hinman and by Hepler that the type of dilatation produced depends upon whether the pelvis is intrarenal or extrarenal. Rabbits, the animals used by Horsford, have completely intrarenal pelvises (Fig. 13). When a rabbit's ureter is obstructed an intrarenal hydronephrosis develops. If a high ureteral obstruction occurs in a patient whose pelvis is intrarenal an intrarenal hydronephrosis naturally results (Fig. 14). If the pelvis is extrarenal the result will be an extrarenal hydronephrosis (Fig. 15). Intermediate types are also observed.

The majority of pelvises in the human being are partially, if not largely extrarenal and this may be explained by the mechanism of renal growth as described by Kelly and Burnam (Fig. 12). The difference in the type of hydronephrosis in the case of an extrarenal pelvis apparently is due to the fact that the renal parenchyma fails to envelop completely the pelvis. An extrarenal pelvis which has no surrounding parenchyma to enclose and support it, cannot resist an increase in intrapelvic pressure. The assistance rendered by the lying renal parenchyma in resisting intrarenal pressure is further emphasized by cases in which thin atrophic areas undergo dilatation out of all proportion to the rest of the kidney. Horsford also produced a saccular dilatation of an infarcted area of renal cortex in a rabbit by obstructing the ureter after ligating a branch of the renal artery.

A comparison was made between pathological specimens of hydronephrosis in the Pathological Institute in which the obstruction was at the ureteropelvic junction on the one hand and in the lower urinary tract or lower ureter on the other. From this it was found that in the early cases parenchymal compression was as conspicuous a feature in low as in high obstructions when the pelvis was extrarenal in type (Fig. 16). In the later stages if the pelvis were intrarenal situated, a corresponding cortical compression existed in both groups. The belief therefore that a so-called pelvorenal hydronephrosis is a characteristic feature of low obstruction and that a predominantly pelvic dilatation is indicative of a primary neuromuscular disturbance of the renal pelvis is without support. Furthermore the contrast between the grossly funnel-shaped dilatation following low obstructions and the globular ap-

pearance of the pelvis in vascular obstructions can be explained simply by the effect of the location of the blockage, for, as Braasch has pointed out, in the cases associated with accessory vessels, the dilated pelvis in the early stages is likewise pyriform in shape.

Therefore, it would appear unreasonable to impute to so dubious a factor as neuromuscular dysfunction the mere, rounded contour of an extrarenal hypopelvis. Moreover, the fact that improvement followed relief of obstruction at the ureteropelvic junction in the series of cases herein reported is sufficient proof that such dysfunction, in these cases at least, could have played no rôle.

#### RESULTS OF CONSERVATIVE SURGICAL PROCEDURES

*Group A Accessory renal vessels the only demonstrable cause of obstruction, 11 cases.* It is evident from a study of Figures 2 to 10 that anatomical improvement in the kidney occurred in each of the 9 patients submitting to postoperative urography. In 6 cases, the improvement was marked, in 2, moderate, and in 1, slight. In 1 case (B.U.I. 17344) no postoperative urogram was obtained. Of the 6 patients showing marked reduction in size of calyces and pelvis, two had normal function before operation. In the 4 others, the renal function, which had been found impaired on admission, was markedly improved. All but one (B.U.I. 19905) had sterile urine on admission. The 2 patients showing moderate improvement in the pyelogram also had sterile urine on admission. One showed moderate improvement in renal function, and the other had no test of function made after operation. The 1 patient (B.U.I. 4632) whose postoperative pyelogram revealed only slight improvement, had bacteriuria on admission, but division of the obstructing vessel resulted in marked improvement in renal function and disappearance of the infection. There was complete relief of symptoms in every case.

*Group B Accessory renal vessels associated with stricture at the ureteropelvic junction, 8 cases.* In this group the anatomical improvement as revealed by urogram, was marked in 3 cases, moderate in 2 and slight in 2. There was no postoperative record in 1 case. Of the 3 showing marked improvement, two had a considerable increase in renal function, and one, a moderate increase. All had sterile urine before operation. Of the 2 patients with moderate structural improvement, one had a considerable increase in renal function with disappearance of the pre-existing infection. In the other case, the function

was normal and the urine sterile before operation. In the 2 patients with slight anatomical improvement, one showed a marked increase in renal function but the other had a normal function on admission, at which time the urine of both was reported sterile. In 7 of these patients the symptoms were completely relieved. One patient (B.U.I. 26210) with bilateral hydronephrosis, had no symptoms referable to the left kidney. Plastic operation on this side was carried out because the urogram showed considerable dilatation of pelvis and calyces.

An investigation of the various conditions influencing the postoperative result, following complete relief of the obstruction, revealed several interesting facts. With one exception (B.U.I. 19905) cases of severe renal infection or advanced hydronephrosis with marked cortical atrophy were subjected to nephrectomy. This indicates that the success of conservative surgery would be expected to vary indirectly with each of these two conditions, although newer technical procedures are reducing still further the number of nephrectomies. In general, the best results were obtained in the older patients in both Group A and Group B. The duration of the symptoms *per se* was of little significance, the important factor seemed to be the relation of the duration to the completeness of obstruction, which, in turn was reflected in the degree of cortical compression. This, and not the mere size of the pelvic sac, was the significant feature.

#### CONCLUSIONS

A primary disturbance of the neuromuscular activity of calyces and pelvis resulting in dilatation localized above the ureteropelvic junction has never been observed in the Brady Urological Institute. The predominance of calycal or of pelvic dilatation depends more upon the original situation of the renal pelvis than upon the actual location of the obstruction. Accessory vessels at the lower pole of the kidney are frequently found associated with obstruction in the region of the ureteropelvic junction. In some of these cases the underlying cause is stricture, which, when present, is probably a primary pathological entity.

In certain cases of hydronephrosis accessory renal vessels are the chief cause of the obstruction, which is precipitated, usually in early adult life, by the effect of one or more subsidiary factors, of which the mechanism of renal growth is possibly one of the most important. Surgical intervention designed to eliminate obstructive contact is indicated. Success depends largely

upon severity of infection and extent of cortical destruction

# REFERENCES

- ALLEMAN, Ztschr f Urol 1935 29 414  
 BLANC and BOURLAND J d urol 1935 40 23  
 BRAASCH Pyclography Philadelphia and London W B Saunders Co 1915  
 Idem J Urol 1925 23 383  
 EKENBOM Arch f klin Chir 1907 82 955  
 FOLEY Personal communication  
 HEPLER J Urol 1937 38 503  
 HINMAN Principles and Practice of Urology Philadelphia and London W B Saunders Co 1935  
 HOSFORD Lancet 1931 1 435  
 KELLY and BLUM Diseases of the Kidneys, Ureters and Bladder New York D Appleton and Co 1914  
 QUINBY J Urol 1937 38 673  
 RAYER Traité des Maladies des Reins 1842 (Cited by Foley Mon Med p 320 May 1924)  
 STANFORD Tr Am Ass Genito Urin Surg 1916 19 10  
 WINSLEY WHITE Brit J Surg 1925 13 247  
 YOUNG Surg Gynec & Obst 1932 54 26

# INTRACRANIAL SOLITARY CHONDROMA

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**I**NTRACRANIAL chondromas, i.e., true progressive neoplasms composed of cartilage, appearing in tissues not normally containing cartilage (v Rindfleisch), are of very rare occurrence<sup>1</sup> The large treatises on the neoplastic disease mention the tongue, the tonsils, the subcutaneous tissue, the skin of the neck, the thyroid, the salivary and the mamillary glands, the diaphragm, the uterus, the testicles, the bladder mucosa, and the corpus vitreum, but wholly omit the intracranial cavity as the possible site of those heterologous neoformations

It seems worth while, therefore, to add to the list of intracranial chondromas summarized below, one personal observation, inasmuch as it presents some interesting features. There was a definite history of trauma 6 years preceding the appearance of symptoms caused by the tumor The parietofrontal chondroma developed at the very region of a previous skull fracture Contrary to almost all of the cases found in the literature, presenting usually a clear cut picture of a brain tumor, the clinical syndrome of our patient, consisting of headaches, vomiting, psychic and emotional changes, dilatation of the right pupil, right lower facial paresis, and attacks of rotation of the head to the right, was none too easy to interpret The huge neoplasm had caused most probably an almost complete obliteration of the cerebrospinal fluid spaces of the brain. The tumor was free from any gross attachment to the surrounding structures

## REVIEW OF THE LITERATURE

Hirschfeld (1851) was probably the first to record an intracranial tumor of the chondroma group Diagnosed as such by Robin, the small cartilaginous nodule found at autopsy in a woman about 35 years old, had grown out from the base of the skull in the left medial fossa, centrally to the gasserian ganglion The clinical history was not given Firket's (1881) tumor, mentioned by Alpers (1935), was an autopsy finding It meas-

ured 15 centimeters in diameter and was attached to the dura mater. Nixon (1892) reported a case found at operation—a "cartilaginous tumor" partially removed in a patient 28 years old The tumor was connected with the superior longitudinal sinus and compressed the superior part of the right motor area of the brain The skull overlying the tumor was distinctly thickened. In Letterer's (1920) first autopsy case, a man of 27 years, the chondroma was located between the two sheaths of the tela choroidea of the third ventricle The tumor, the size of a cherry, was attached to the fornix His second case was that of an epileptic who had, in addition to a left temporal glioma, a chondroma embedded in the plexus choroideus of the left lateral ventricle It too was the size of a cherry and was attached to the plexus with a small pedicle Huebscher (1922), according to Bruett (1931), found at autopsy on a woman, who died from tuberculous meningitis, a small chondroma located at the border of the frontal and parietal bones The tumor was cystic in the center.

With Neuman (1927) begin the modern records of the surgical removal of intracranial chondromas His patient, a 22 year old male, had a tumor in the left temporoparietal region, producing cephalalgia, vomiting, and transitory loss of consciousness, for 6 months The very large chondroma had apparently no attachment either to the dura mater or to the falx cerebri or to the base of the skull to which it was said to extend Sillevis Smitt (1929) records a case of a man, aged 29 years, operated upon by Laméris This patient suffered with headaches, vomiting, somnolence, papilledoma, progressive loss of vision, and a right spastic hemiparesis The symptoms started after some psychic difficulties The chondroma weighing 128 grams, was located in the left parietal region and produced an endostosis which was visible on x-ray examination It was attached to the dura mater which, in turn, could not be separated from the overlying bone The 65 gram chondroma which was removed by Petit-Dutaillis from a man of 23 years and reported with Guillain, Bertrand, and Schmite (1930), and which caused headaches, papilledema, and left sided Jacksonian seizures, was connected with the pachymeninx in the right frontoparietal region In

<sup>1</sup>We are excluding from the present review all of the cases characterized by a more or less generalized chondromatosis with occasional intracranial localization of the cartilaginous neoformations

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Fig. 1. A schematic drawing to show the two most frequent localizations of the intracranial chondromas: parietal region (10 cases) and the base of the skull (6 cases).

Brucet's (1931) case the tumor lay in the left frontoparietal area and produced an endostosis of the bone. Beneath the bony spur the dura mater was absent. The huge chondroma reaching medially to the falx cerebri and extending downward was compressing the brain to such an extent that the base of the skull was clearly visible in the anterior cranial fossa. For 5 years it had caused headaches and for 4 years papilledema, right hemiparesis and right epileptic seizures had been noted. In Schuessler's (1931) case, the chondroma of the left frontoparietal region was as large as one's hand. It was removed, but the patient was not cured completely by the operation.

The falx cerebri was mentioned as the site of origin of the chondromas described by Froment, Wertheimer and Dechaume (1932) and by Verbrugghen and Learmonth (1932). In the first instance, the patient died after operation and from microscopic examination of sections of the tumor a diagnosis of benign chondroma was made. The growth was said to extend along the perivascular spaces to the two cerebral hemispheres. In the second instance the patient, 37 years old, had a neoplasm causing Jacksonian seizures at first only in the lower then in both left extremities with a subsequent hemiparesis. The tumor produced no signs of increased intracranial pressure. Glatzel operated upon a patient of Artamski (1913-1934) aged 26 years who presented the typical picture of a right frontal tumor. The huge chondroma was attached to the dura mater on a wide surface. The patient was cured by the total enucleation of the tumor but 3 years later he began to have epileptic attacks occurring every month or two. Discussing Martin's (1934) report H. Roger (1934) mentions a case not reported in the literature, of a very large chon-

droma of the parietal region extending toward the base of the skull and producing symptoms of a seemingly typical tic douloureux. Wolf and Echlin (1936) mention a case seen by the second author, of an enormously huge chondroma firmly attached to the base in a patient aged 64 years. An attempt to remove it at postmortem resulted in making an opening into the pharynx. Unfortunately, nothing is said about the intravital symptomatology.

Closely allied to the pure cartilaginous tumors are the mixed but not pluridermal neoplasms: viz. the myxochondromas, myxochondro-angiosarcomas, osteochondromas, and the fibro-osteochondromas.<sup>1</sup> Cushing (1932) states that in his series of 2,033 cases of intracranial tumors only 3 were osteochondromas of the cranial base projecting up into the cranial chamber. Jakob and Pedace (1933) report an autopsy case of a woman aged 43 years who presented *intus vitem* visus and auditory hallucinations and symptoms of a sensory neuropathy. Four years after the onset of the disease the patient had an ictus apoplecticus and died. A benign diffuse fibro-osteochondroma with a fresh hemorrhage in the center of the tumor was found to invade the left parieto-occipital region of the brain. There was no attachment to the meninges. Platon (1913) removed an osteochondroma connected with the falx cerebri and Levitt (1934) an osteochondroma situated on the left side of the sella turcica. The 6-year-old woman suffered with left-sided cephalalgia and visual disturbances. Objectively she had an almost complete left ophthalmoplegia, bilateral corneal hypesthesia, the roentgenograms showing on the left a calcified parasellar tumor. After its total removal the patient recovered completely. According to Ewing (1934), Oppenheim described a calcified myxochondro-angiosarcoma as large as the fist, developing in the frontal region of a 16-year-old boy 8 years after injury.

The tumor in Martin's (1935) case was located between the cerebral hemispheres. The very large myxochondroma compressing the corpus callosum had no attachment whatever, the falx cerebri being wholly absent. In spite of that the tumor is called a voluminous myxochondroma de la faux du cerveau. The patient had suffered for 7 years with headaches, vomiting, diplopia, and lowering of the visual acuity. With time he became irritable, developed a bilateral papillo-

<sup>1</sup>The histologic and the osteologic investigations are of limited value in these cases. They rarely show inclusion of cartilage. The histologic picture is that of a myxoma. It is usually well circumscribed, but the tumor is not encapsulated. The tumor is composed of a mixture of cartilage and connective tissue. The tumor is usually found in the frontal region of the brain. The tumor is usually found in the frontal region of the brain.

dema, bilateral central scotoma, and a left spastic hemiparesis. Roentgenograms showed "a light intracranial shadow." Alpers (1935) reports a case of a recurring osteochondroma removed twice. The 49 year old man was operated on for the first time in 1921 because of Jacksonian seizures starting in the right lower extremity. An osteochondroma was found to grow out from the falx cerebri. Seven years later the patient was again operated upon for the relief of right hemiparesis; the x-ray pictures indicated in the left parietal region, slightly anterior to its previous location, a recurrence of the partly calcified neoplasm. Microscopically, the tumor proved to be also an osteochondroma.

All of these benign tumors (with the exception of the invading chondroma of Froment, Wertheimer, and Dechaume and of the fibro-osteochondroma of Jakob and Pedace) were hard, elastic, rounded, lobulated, and encapsulated tumors, often reaching great size. The milky-opaline surface of the neoplasms made their cartilaginous nature quite obvious on inspection. Men seem to be much more frequently afflicted with these tumors than do women. The average age of the patients was 30 years, the youngest being 16, the oldest 64 years. The left side of the skull was affected 9 times, the right only 4. In the other patients the tumor was located centrally or its site was not stated. The parietal region of the brain seems to be the most common site of the chondromas (Fig. 1), 10 out of the total 25 tumors were encountered hereabouts. The frontal region was involved three times, the third ventricle, the lateral ventricle, and the motor region, each harboring one neoplasm, the base of the skull was the site of the tumor in 5 other tumors. In 4 instances the neoplasm was attached to the falx cerebri, in 3 instances it was connected with the dura mater of the convexity of the brain, in 1 with the superior longitudinal sinus, in 1 with the fornx of the third ventricle, in 1 with the plexus choroideus of the lateral ventricle, in 5 with the base of the skull, and in 4 no attachment to the surrounding tissues was noted.

As to the duration of the symptoms from their onset to the time of operation or autopsy the shortest period was 4 months, the longest, 7 years. The most frequent complaints noted in the case histories are a more or less advanced hemiparesis and epileptic attacks of the Jacksonian type, together with signs of increased intracranial pressure. The last were lacking in only 1 case (Verbrugghen and Learmonth). An endostosis overlying the tumor was seen in 3 cases. In 3 instances the neoplasm was revealed

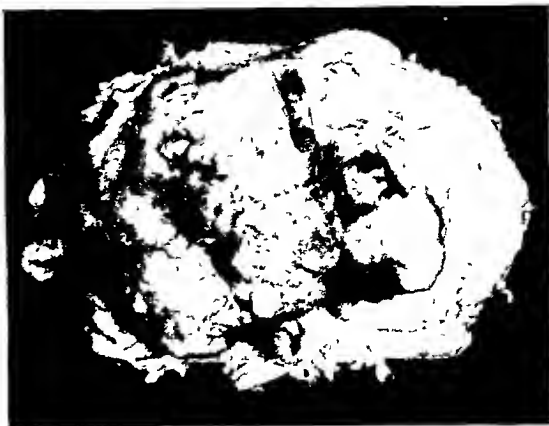


Fig. 2 The appearance of the removed chondroma. Tumor weighed 220 grams. Two-thirds natural size.

by shadows of calcification. In 1 case the symptoms appeared 8 years after trauma (Oppenheim), in 1 subsequent to some psychic difficulties (Sillevis Smitt). In other reports no mention is made about any possible inciting agents of the disease. In 9 of the 25 recorded benign tumors the diagnosis was made at autopsy and in 16 instances at operation. Two patients died after operation (Nixon and Froment, Wertheimer and Dechaume), and 14 were cured by the total removal of the tumor. In Alpers' patient, the osteochondroma recurred twice.

#### REPORT OF CASE

S. F., aged 31 years, farmer, married, was admitted to the Neurosurgical Division on May 1, 1937. In September, 1931, he was hit by a heavy stone in the right parietal region. After the accident he did not lose consciousness but complained of severe headaches, nausea, and vertigo. There was bleeding from the right ear and nose. The x-ray pictures of the head showed a closed, depressed fracture in the right parietal region, from which three linear fractures were seen to descend toward the base of the skull. Two days after the accident, during which the patient complained only of cephalalgia, he was operated upon in the County Hospital in Skierniewice (Dr. Witkowski), and all the depressed bone fragments were elevated and removed. The dura mater was found to be severed but the inspected part of the brain appeared normal. The patient left the hospital 9 days later, feeling entirely well.

In June, 1936, patient's home was burned and he became depressed. He complained of attacks of severe headache localized chiefly in the left half of the skull, occurring at first rarely, then once a week, sometimes accompanied by vomiting. One and a half months before admission he started to be at times jocular, at times irritable and ready to cry for no reason at all. According to the family, several times, during periods of cephalalgia, he had some attacks of rotation of the head to the right, no seizures being observed. On admission patient was very apathetic and slow but oriented as to the time, place, and current events. When in the hospital he urinated several times in the ward and was frequently found to wet his bed involuntarily.



Fig 3 Photomicrograph showing the stellate cells containing peculiar vacuoles. The other cells in process of atrophy and degeneration. The homogenous hyaline matrix staining pale rose.

There was nothing pathological in internal organs neurologically only some weakness of the lower branch of the right facial nerve and a dilatation of the right pupil was noted. Otherwise the examination as well as the laboratory findings (the cerebrospinal fluid blood and urine) were essentially negative. Roentgenograms of the skull showed in the right parietal region a fairly well defined loss of bone substance 8 centimeters long and 2.5 centimeters wide. On palpation the bottom of this bone defect felt rather hard and rugged and it was thought that it was probably filling out by still uncalcified new bone formation.

To establish the diagnosis ventriculography was attempted on May 4, 1937. Several attempts to puncture the cellula media of the right lateral ventricle was unsuccessful.



Fig 4 Photomicrograph showing cells the cytoplasm of which extends into processes entering the amorphous matrix.



Fig 5 Photomicrograph showing the transition of the chondrocytes into compound granular corpuscles seen first in the perivascular space of a small blood vessel.

The left ventricle was reached at normal depth but only 10 cubic centimeters of the cerebrospinal fluid could be withdrawn and the same amount of air introduced. However during the procedure the restless and loudly crying patient pushed out apparently all of the injected air from the ventricles for the x-ray plates showed no air inside the skull. The same day an encephalogram was made 30 cubic centimeters of air being injected in 5 cubic centimeter portions. But just before the completion of the procedure the air rushed back through the needle and none entered the skull. The next day encephalography was repeated (50 cubic centimeters of air being introduced) but for the second time the result was negative. Practically no air entering either the ventricles or the subarachnoid spaces of the brain.

Although we were at a loss how to explain these unusual difficulties in introducing air both into the ventricular and the subarachnoid system we decided to explore the region of the skull fracture. Our assumption was that the patient's headaches, his psychic and emotional disturbances might be due to a subdural hematoma situated over the right cerebral hemisphere causing the discrete paresis of the right oculomotorius (dilatation of the pupil) and compressing the right lateral ventricle. By pushing the contralateral (left) cerebral hemisphere toward the wall of the skull the hematoma could thus produce the homolateral (right) lower facial weakness and the attacks of rotation of the head to the right.

Accordingly on May 5, 1937 a right frontoparietal osteoplastic flap was turned down with the skull defect at its base. A ventricular needle introduced through the very tense and non-pulsating dura mater encountered just below the uncovered pachymening a hard resistance. Our first impression was that we might be dealing with a depressed bone fragment left here unintentionally at previous operation but we soon found that it was a huge tumor. The wholly encapsulated and lobulated neoplasm, almost as large as one's fist was easily enucleated (Fig 2). It occupied the parietofrontal region; it was located parasagittally in the parietal region and extended toward the base of the skull in the frontal region. The tumor had no attachment either to the dura mater or to the falx cerebri. No blood vessels of any importance were seen to connect it with the surrounding cerebrum. The cortex was dry and



Fig 6 Photomicrograph showing a large blood vessel with a widely dilated perivascular space growing from the perichondrium between two lobules of the chondroma. The perivascular space loaded with compound granular corpuscles

anemic, and the non-pulsating brain, which was pushed laterally and backward, showed no tendency to fill out the large cavity resulting from the enucleation of the neoplasm. During the removal of the tumor the patient—slightly shocked by the procedure—had a generalized epileptic attack but otherwise went through the operation quite well.

Except for a left motor and sensory hemiplegia, which developed immediately after the extirpation of the tumor and subsided 4 days later, the postoperative course was uneventful and the patient left the hospital on May 26, 1937, entirely free of signs and symptoms. Unfortunately we lost track of him and cannot report his present condition.

The case was presented before the Warsaw Neurological Society, May 26, 1937.



Fig 7 Photomicrograph demonstrating the collagenous area of the chondroma

Microscopic examination revealed the tumor to be a chondroma of the hyaline variety, although here and there some collagenous areas are also present. No elastic fibers were demonstrable in the matrix with special stains. In some places the amorphous hyaline matrix was very young, and showed a definite affinity to hematoxylin, in other sections it stained with eosin. As a whole there was great variation in the density and intensity of the eosinophilic staining of the matrix. With the Van Gieson method it became brown in some areas, like adult cartilage. In sections where the matrix was well formed the cells, varying greatly in size and shape, were usually round, oval, or fusiform, and lay in distinct capsules, singly or twofold. The cells were often gathered into large or small groups. In sections with imperfect formation of matrix, the staining was pale-rose, the cells were also stellate and contained commonly peculiar vacuoles, which resembled those described by Virchow as "physaliden" (Fig 3). In some places the cartilage capsules, which were not always very distinct, were either empty or wholly absent and the cells lay then directly in the matrix. In such areas there were

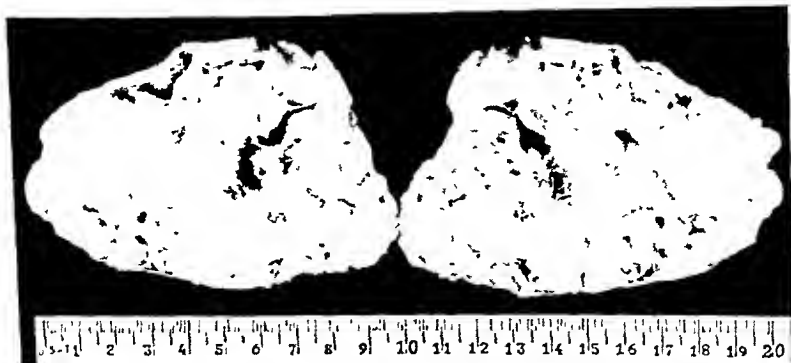


Fig 8 Cross section of the chondroma showing multiple areas of degeneration leading to the formation of small cysts and cavities



Fig 9 Photomicrograph demonstrating the so called asbestos transformation of the homogeneous matrix

also cells with cytoplasm which extended into long processes entering the interstitial tissue. Often fat granules were seen in the cells, some of which had the appearance of compound granular corpuscles. The latter (Fig 5) were found especially in the widely dilated perivascular spaces of the blood vessels which issued from the perichondrium and extended into the interior of the tumor with the connective tissue septa (Fig 6). Such septa divided the chondroma into single cartilaginous lobules. The thick or thin collagenous bundles formed either a dense network running in all directions or they were gathered together into distinctly oriented fibers (Fig 7).

The perichondrium was composed of bundles of connective tissue fibers more or less closely twisted and applied each to the other. The border line between the perichondrium and the cartilaginous matrix was often not very distinct, the cells under the perichondrium being flattened and running in a plane parallel with the surface of the

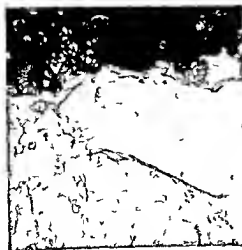


Fig 10 Photomicrograph showing one of the cavities formed by confluence of cell lacunae. The arrows indicate some of the enlarged lacunae opening into the cavity



Fig 11 X-ray picture of the removed chondroma showing foci of calcification. They were invisible on roentgenograms of the skull made before the operation

tumor. Here and there one had the impression of the presence of intermediate forms between the perichondrial fibroblasts and the cartilage cells. The regressive changes were leading to the formation of cysts of various sizes which were visible to the naked eye when the tumor was cross sectioned (Fig 8). Such cysts were filled out either with a serous or a mucin like material. Under the microscope the processes of degeneration were found in different stages and in different forms. For instance the usually homogenous matrix was fibrillated, softened and rarefied (the so called asbestos transformation, Fig 9) or it was a cavity which was either empty or contained some undissolved material. Such cavities were not necessarily the result of softening, because they could have been produced by the confluence of cell lacunae which had become irregular and enlarged (Fig 10). The calcification—as seen also on x-ray pictures of the removed tumor (Fig 11)—was limited to the most superficial layers of the neoplasm, the lime salts being deposited in the matrix in form of homogeneous masses.

We maintain our assumption that the discrete signs on the side containing the verified lesion were most probably caused by the huge chondroma which pushed the other hemisphere toward the wall of the skull. We also maintain that the difficulties encountered in introducing the air both into the ventricular and the subarachnoid system were due to a serious obliteration of the cerebrospinal fluid spaces by the tumor and the compressed brain.

The not infrequent homolateral involvement of the pyramidal tract in the presence of a brain tumor and of a subdural hematoma is at present a well known fact. Of the several possible causes of such an involvement we will mention only two, viz., notching of the contralateral crus cerebri by the free margin of the tentorium and compression of the contralateral cerebral hemisphere toward the wall of the skull. In this connection we would refer to the detailed reports of Gould (1928) and of Kernohan and Woltman (1929).

However, the presence of a cartilaginous tumor inside the cranial cavity raises the question as to origin. Such tumors lie free of any gross connections with the surrounding structures, and are more or less finished products of abnormal growths, so that it is not surprising that the origin of the growth cannot be positively determined. As in our case so it has been with many other chondromas reported in the literature. Many explanations have been given as to the source of such intracranial tumors.

For the majority of chondromas developing in the soft tissues it is generally seen in embryonal cartilaginous cell groups misplaced by dysontogenesis. If this hypothesis as to the etiology of some cartilaginous tumors located elsewhere, is accepted, as it usually is, there is no good reason that the hypothesis should not hold good at least for some intracranial chondromas.

Since the base of the skull at first is entirely formed of cartilage, the origin of chondromas situated here may be explained on the ground that some cartilage cells left during the developmental period retained their embryonal character and gave rise to chondroma formation. This explanation looks plausible *prima vista*. However the vault of the skull is commonly considered to be composed of membranous bones so that such a hypothesis rests on less firm ground. Looking closely to the problem—at least as regards the higher vertebrates—it would seem that, since the ontogenesis of the human skull repeats in many details its phylogenesis, it is perhaps permissible to look for the source of the chondromas in persistent embryonal cartilage rests, even when growths are located on the roof of the cranium. According to Dursy (1869) some portions of the cranium *primordiale* regress in later stages of development and are replaced by membranous bones. Such is the case with the part replaced later by the parietal bone but some of its cartilaginous portion fails to disappear completely. It merges with the membranous part so that the permanent parietal bone is finally composed of both the cartilage and dermal elements. Therefore the dermal origin of the vault of the skull is by no means absolute. Minot (1884) is of the same opinion and maintains that at the time when the cartilaginous skull is stretching and growing upward it comes in close contact with the dermal frontalia, parietalia, and interparietalia, so that when they finally ossify the permanent bones contain some cartilaginous elements. Bonnet (1891) supports these opinions, inasmuch as he showed that the membranous skull contained some cartilaginous foci. Koelliker (1893), who demon-

strated cartilage in the squama of the temporal bone, a finding confirmed later by Gaupp (1901), asserts that the membranes from which later some parts of the frontal, temporal, and parietal bones, some parts of the nasal bone and of the vomer are formed, may be considered as belonging to the perichondrium of the primordial cranium or as its continuation.

In connection with the data quoted pointing toward the possible dermomembranous origin of the parietal bones it might be worth while to re-emphasize the frequent occurrence of chondromas around that exact region of the skull (Fig. 1).

Most of the tumors reported were closely attached to the dura mater. It is, of course, a well known fact that foci of superfluous cartilage are found in the periosteum of skeletal bones. It is true that contrary to the bony plaques not infrequently found in the dura mater and in the arachnoidea and to the arachnoidal inclusions encountered in the dura mater, no cartilaginous foci—embryonal or adult—have heretofore been reported as present in the meninges. This might be due to the lack of careful search for them. Theoretically, however, the growth of dural chondromas, as well as of those attached to the falx cerebri and to the superior longitudinal sinus from embryonal cartilaginous rests misplaced from the bones of the skull into the dura mater, is perhaps possible also in other sites than near or at the base of the skull. The same is true for the chondromas reported as lying grossly free in the cranial chamber, i. e., not connected either with the skull or with the dura mater, tumors which in our opinion are of leptomeningeal origin, and in which some discrete attachment to the arachnoidea is easily overlooked during removal of an often very large tumor. The presence of aberrant embryonal cartilaginous rests in the leptomeninges might be explained as follows. The young vascularized mesenchyme which will later build up the pia mater grows both from above—from the primitive falx—and from below—from the base of the skull. It is therefore possible that the budding young blood vessels included in the embryonal pia mater creeping over the entire brain may carry with them colonies of cartilage cells and deposit these cells as they proceed on their way. It is important, we feel, to note that with the exception of the 2 cases of Letterer (1920), in one of which the tumor was connected with the tela choroidea of the third ventricle, and in the other the growth was attached to the plexus choroideus of the lateral ventricle, none of the reported chondromas was really intracerebral.

Although imbedded in the brain substance, they were all extracerebral. As he noted cartilage like cells in the mesenchyme above the choroid plexus anlage in a 10 week embryo, Letterer (1909) considered his case of chondroma of the third ventricle to be the result of misplaced embryonic cartilaginous cells.

There is another way to explain the source of intracranial chondromas than by budding of the aberrant embryonal rests of cartilage. If it is true that common connective tissue tumors of the cranial cavity are derivatives of the pluripotential undifferentiated mesenchyme, then one is forced to the conclusion that at least some of the intracranial chondromas are the result of neoplastic growth of undifferentiated mesenchymal cells. As such cells are able to give birth to meningeal mesenchymatous, angioblastic, meningotheliomatous, psammomatous, osteoblastic, fibroblastic, melanoblastic, sarcomatous, and lipomatous neoformations (Bailey and Bucy, 1931), a chondroma closely connected with the meninges would be nothing but another variety of a 'meningioma,' and the plurivalent mesenchymal cells persistent in the meninges, would develop into chondrocytes (Maximow, 1934). The neoplastic budding of the embryonal mesenchyme instead of persisting (in adult meninges), may be misplaced by dysontogenesis, for instance, to the surface of the medullary canal and produce a chondroma in a place one would hardly expect to be the site of such a neoplasm. In fact Letterer (1930) explains his second case of chondroma on the ground that some remnants of mesenchymal cells of the dura mater were misplaced in the lateral ventricle and there formed a cartilaginous tumor. Indeed, he mentions the theory of Feré (1896), that the very young undifferentiated tissue is capable not only of growing in foreign tissues but of becoming differentiated into cartilage.

The fibroblast is also pluripotential however, and is capable of producing osteoblasts, osteocytes, and chondrocytes (Maximow, 1934). Beneke (1903) believed that cartilaginous tumors of the subcutaneous tissue of the mamillary gland of the bladder mucosa and of the corpus vitreum are best explained by metaplasia of connective tissue. The ideas of Sillevius Smitt (1929) and of Bruett (1931) are very much the same. Smitt taking into consideration the fact that the outer layer of the dura mater represents the cranial endosteum and that all periosteum has the ability to form cartilage (cartilaginous callus), expresses the opinion that the dura mater might also under certain circumstances take up that

potential function and "running off the rails" produce a chondroma. This consideration of the potentialities of the dura mater is based on the results of some physiological experiments. Cohnheim and Mass (1877) introduced into the jugular vein of experimental animals particles of tibial periosteum, and found in the blood vessels of the lungs, 10 to 16 days later, that the inside of the periosteum was covered with layers of hyaline cartilage cells. Before then and after 30 days, however the result was negative. Koller (1886) demonstrated that not only the periosteum of the bone preformed in cartilage has under certain circumstances the ability to form cartilage but that the same is true also for the periosteum of bones preformed in skin (experiments on rabbits).

Guilaum et al (1930), having established near the blood vessels of the tumor some stages of a rapid transition between the normal connective tissue elements, the fibroblasts and the neoplastic chondroblasts, believe that the chondroma resulted from the transformation of a connective tissue layer, probably the dura. Alpers (1931) believes that in his case the osteochondroma was derived from meningeal fibroblasts. The above of view again link the intracranial chondromas with the meningiomas, Mallory (1920) and Penfield (1923) uphold the idea that the meningeal (arachnoidal) fibroblasts are the source of common meningeal tumors.

The explanation of the origin of the chondromas on one hand by budding of the embryonal cartilaginous rests left in place (chondromas attached to the base of the skull) or misplaced into the neighboring tissues and on the other hand by development of those tumors from persistent and aberrant foci of meningeal mesenchyme or from leptomeningeal fibroblasts (chondromas attached to the dura mater and to the leptomeninges) is only a part of the problem, the "why" of this budding is the rest.

The casual relationship between new growth formation and trauma, inciting to action a latent *genus loci*, has ever been a much discussed question. According to Borst (1902) the percentage of cases attributed to trauma ranges between 7.5 and 44.7 per cent. As is well known, trauma in addition to some irritative processes such as pachymeningitis is often thought to play an important rôle in the etiology of meningeal tumors. The presence of inflammation and trauma preceding the appearance of chondroma especially of the long bones is also a frequent etio-

Letterer (1930) call his tumors hemangiomas (Ulbrecht) Jakob and Pedace (1931) use the term hamartoblastoma.

logical finding. However, except for the case of Oppenheim, reported by Ewing (1934), in the reported intracranial chondromas, no injury to the head is mentioned as preceding the appearance of the symptoms. We feel that our case fulfills all the clinical and pathological requirements necessary to assume a causal relationship between the injury and the formation of the tumor: the microscopically verified tumor, of slow growing variety, developed in the very region of a severe skull fracture sustained 6 years previously by a man up to then apparently healthy. It is true that the tear in the dura mater at the time of the débridement was only 1 centimeter long and, as no further openings were made, not much of the underlying brain could be inspected. However, the patient before the accident was entirely symptomless, the brain pulsated and the portion seen at the operation appeared normal. We believe therefore that we are at least near the truth when we state that a causal relationship most probably existed between the skull fracture and the appearance of the chondroma.

Therefore, several possible explanations of the source of the grossly free lying chondroma are open to discussion. An injury causing fragmentation of the parietal bone might free some embryonal cartilaginous rests still remaining from the development of the bone, consisting perhaps of melting down of dermal and cartilaginous elements. The liberated colony of cartilage cells being thrown under the pachymeninx, may arrive in the meshes of the arachnoidea, and apparently finding suitable conditions for further growth and behaving here "as the wild beasts which escaped their cages" (de Quervain) produce a chondroma. Or, a fragment of fractured bone may cause a dormant embryonal cartilaginous or mesenchymal cell colony misplaced or persistent in the leptomeninges to bud and to form a cartilaginous new-growth. Finally, the same bone fragment might incite the leptomeningeal fibroblasts to give origin to a chondroma. Any one of those possibilities may play a rôle in the formation of a chondroma, but none can be proved decisively to be the cause, as unfortunately the only two elements at our disposal to judge the problem on are (1) the trauma and (2) the fully grown cartilaginous tumor.

#### SUMMARY

- 1 The rare occurrence of solitary intracranial cartilaginous tumors is emphasized
- 2 The salient clinical features of the 25 cases recorded in the literature, including 16 pure chondromas and 9 mixed but not pluridermal cartilaginous new-growths, are briefly reported.

3. One personal observation of a solitary chondroma of the right parietofrontal region in a man aged 31 years is presented. The tumor appeared at the exact site of a depressed skull fracture sustained by a man healthy until 6 years ago, when he sustained the injury which produced headaches, vomiting, vertigo, psychic and emotional disturbances, a right lower facial paresis and dilatation of the right pupil. The patient is said also to have suffered attacks of rotation of the head to the right. The psychic and emotional changes and the dilatation of the right pupil could easily be explained by the presence in the right half of the skull of a huge neoplasm, weighing 220 grams, seriously compressing the frontal lobe and the right oculomotor nerve. The homolateral signs (attacks of rotation of the head and the lower facial weakness) were probably the result of the chondroma pushing the left cerebral hemisphere toward the contralateral wall of the cranium. The difficulties of introducing air both into the ventricular and subarachnoid system, encountered in our case, were probably also the result of spatial changes inside the skull caused by the expansive and slow growing chondroma. The tumor was completely enucleated and the patient left the hospital cured.

4. The several possible explanations of the origin of intracranial chondromas—including the presented case—are discussed and their speculative character is pointed out. The tumors growing out from the base of the skull or closely connected with the other bones of the cranium (especially at or around the parietal region) are probably best explained by tumor-like budding of cartilaginous rests persistent there from the early development of the skull. Young mesenchyme or the fibroblasts of the pachymeninges and leptomeninges may be the source of the chondromas attached to the dura mater of the convexities, falx cerebri, or the superior longitudinal sinus and of those which are described as lying free from any gross connection with the surrounding tissues but which, in our opinion, are most likely connected with the leptomeninges. No truly intracerebral chondromas have been reported. Trauma may be said to be the provocative agent in producing these abnormal growths.

#### BIBLIOGRAPHY

- 1 ALPERS, B. J. *Ann Surg.* 1935, 101 27
- 2 ARTWINSKI, L. *Neurol Polska*, 1934-1935, 16-17 84.
- 3 BAILEY, P., and BUCK, P. C. *Am J Cancer*, 1931, 15 46
- 4 BENEKE, E. *Julius Weiss' Chirurgie* P 144 Wien und Leipzig Karl Prochaska, 1901
- 5 BONNET (1891) Quoted from Letterer (1920).



- 6 BORST M Die Lehre von den Geschwuelsten Wiesbaden J F Beigmann 1902
- 7 BRUETT H Deutsche Ztschr f Chir 1911 231 497
- 8 COHNHEIM J and MASS H Arch f path Anat 1877 70 161
- 9 CUSHING H Intracranial Tumours Springfield & Baltimore C C Thomas 1933
- 10 DURS Y (1869) Quoted from Letterer (1901)
- 11 EWING J Neoplastic Disease Philadelphia and London W B Saunders 1934
- 12 FERÉ (1896) Quoted from Letterer (1901)
- 13 FIRKET (1881) Quoted from Vpers (1935)
- 14 FROMENT J WERTHEIMER P and DUCHAUME, J Lyon méd 1937 150 357
- 15 GAUFF (1901) Quoted from Letterer (1901)
- 16 GOLDB E M Arch Neurol & Psychiat 19 9 19 509
- 17 GILLAIN C PETIT DUTAILLIS BERTRAND I and SCHMITE P Bull et mém Soc d hôp de Par, 1930 27 1494
- 18 HIRSCHFELD L Compt rend Soc de biol 1851 3 94
- 19 HUEBSCHER (1922) Quoted from Bruett (1931)
- 20 JAKOB C and IRDACH F A Arch argent Neurol 1933 9 13
- 21 KERNOHAN J H and HOLTMAN H H Arch Neurol & Psychiat 19 9 1 74
- 22 KOELLIKER A Handbuch der Gewebelehre des Menschen Leipzig Wilhelm Engelmann 1893
- 3 KOLLER H Arch f Entwicklungsmech 1906 3 64
- 24 LETTERER E Beitr z path. Anat. u z allg. Path. 19 0 67 370
- 25 LEVITT, J M Arch Ophth 1934 12 8 7
- 26 MALLORY F B J Med Research 1910 41 349
- 27 MARTIN I Rev Neurol 1934 1 1050
- 28 MAXIMOW A A Textbook of Histology Philadelphia and London W B Saunders 1934
- 9 MINOT (1884) Quoted from Letterer (1901)
- 30 NEUMANN A J de Chir 19 7 26 14
- 31 NIXON A Med Press & Circ 189 1 70
- 32 OPPENHEIM H Quoted from Ewing (1934)
- 33 PENFIELD W Surg Gynec & Obst 19 3 3 65
- 34 PLATON E Norsk Mag f Lægevidensk 1931 94 743
- 35 ROGER H Rev Neurol, 1 1934 1 1053
- 36 SCHLESSELER Ch Ueber einen Fall von Chondrom der Schädelhöhle zugleich ein Beitrag zur molekularen Hirnchirurgie, Dissertation Harburg 1931
- 37 SILLEVIS SMIT W G Deutsche Ztschr f Nervenheilk, 19 9 109 1,0
- 38 VERROUCHY A and LERMOUST J K J Nerv & Ment Dis 193 6 413
- 39 WOLF A and ECHLIN F Bull Neurol Int New York 1936 5 515

# ACUTE PUTRID ABSCESS OF THE LUNG

## III. Roentgenographic Features

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**A**CUTE anaerobic (putrid) pulmonary abscess is a primary suppurative disease of the lung, the diagnosis of which is based essentially upon fairly characteristic clinical manifestations and roentgen features. Although the symptomatology of the disease has been the subject of previous discussion (4), little has been written concerning the roentgenographic findings. As a result, a general lack of appreciation of the significance of a number of roentgenographic features of the disease seems to exist. Our purpose in presenting the subject in some detail, at this time, is to emphasize the value of the roentgenogram not only in establishing the diagnosis of acute putrid pulmonary abscess but also in serving as a guide to the prognosis and treatment of the disease.

Roentgenograms in cases of acute putrid abscess of the lung fall into two general groups: first, those disclosing a well defined cavity containing fluid and air, and, second, those disclosing essentially an area of pulmonary infiltration. Films disclosing a cavity of fair size containing a fluid level are also to be seen in such diseases as aputrid necrosis complicating lobar pneumonia, aerobic (non-putrid) pulmonary abscess, tuberculosis with cavitation, necrotic pulmonary neoplasm, small encapsulated pyopneumothorax, partially empty pulmonary cyst, pulmonary infarction with cavitation, and pulmonary cavitation due to infection by higher bacteria (especially streptothricosis and leptothricosis). Films disclosing essentially an area of fairly dense pulmonary infiltration, as noted in the second group of cases of acute putrid pulmonary abscess, are also to be seen in a variety of pulmonary diseases, the most common of which are the pneumonias due to various organisms, tuberculosis, localized bronchiectasis, pulmonary neoplasm, infarction of the lung, etc. Thus, it is obvious that the diagnosis of acute putrid pulmonary abscess cannot be made by roentgenography alone, and that in the final analysis the symptomatology of the patient must constitute the basic criterion of diagnosis. Roentgenography, however, is a diagnostic method of prime importance, and one which is essential for corroboration of the clinical diagnosis. Furthermore, for pur-

poses of accurate localization of the lesion it is indispensable. Finally, it serves as a most reliable guide to the progress and prognosis of the disease. Since the clinician is charged with the responsibility not only of establishing the diagnosis but also of making the decision as to the type of therapy and the time when it is to be instituted, it is essential that he be thoroughly acquainted not merely with the clinical manifestations of the disease but with its roentgenographic features as well.

In order to avoid any misunderstanding of the term "acute abscess," we arbitrarily designate as acute cases those of not more than 6 weeks' duration from the time of onset of pulmonary manifestations (2). The observations about to be recorded are based upon a study of more than 150 such cases. Sixty-five of these have been subjected to operation, at various times within the aforementioned 6 week period, by methods which we already have described (2). These cases are of particular value for purposes of discussion because the actual pathological findings, as disclosed at operation, have been correlated directly with pre-operative roentgen findings. Thus in each case, not only the correctness of pre-operative diagnosis but also the accuracy of interpretation of finer details of roentgenograms have been determined. Prior to our advocacy of operation in the acute stage of putrid abscess of the lung (2), there was little opportunity to study the pathological features of this stage of the disease or to correlate them with the early roentgenographic findings. As a result of our experience with these surgically treated cases, however, we not only have learned much concerning the pathology of acute abscess of the lung, but also have come to appreciate the significance of certain roentgenological findings which formerly appeared to be of little moment. Since correct interpretation of the details of the roentgenogram is based essentially upon a knowledge of the pathological features of the disease, a brief description of the pathology of acute pulmonary abscess now will be presented.

### PATHOLOGY

Acute putrid abscess of the lung, the result of known or assumed aspiration of anaerobically in-

fectured material begins in and distal to one of the smaller bronchi at the site of arrest of such aspirated particulate material. An intense destructive inflammation occurs almost immediately in the involved bronchus and its tributary bronchioles and alveoli. The result is a localized gangrenous bronchopneumonia involving part or all of a bronchopulmonary segment (1). Necrosis and liquefaction of the structures in the involved area soon supervene, and result in the formation of a localized abscess containing foul pus, pulmonary sloughs and detritus. Abscess formation (cavitation) occurs early, and usually is present within a week to 10 days of the onset of infection. The lesion invariably is situated superficially within one of the lobes of the lung. As a result, early and pronounced overlying adhesive pleuritis occurs. This is present in all cases and constitutes a constant pathological feature of the disease. Depending upon the site of the abscess, the visceral pleura overlying the lung in the involved area is agglutinated to the thoracic parietal pleura, to the diaphragmatic pleura, to the mediastinal pleura, or to an adjacent lobe. Thus, the "typical acute putrid abscess as noted at operation is a solitary cavity, varying from 1 to 3 inches in diameter, situated within the lung only a short distance beneath the visceral pleura. The walls of the cavity consist of infiltrated, compressed pulmonary tissue, usually covered by adherent detritus and presenting the mouths of one or more eroded bronchi. The contents of the cavity at any given time, depend upon the degree of necrosis and liquefaction which already has occurred and also upon the degree of spontaneous drainage and aeration which has taken place through the communicating bronchus or bronchi. At a very early stage the involved area is occupied by pulmonary tissue which is undergoing necrosis but still merges with the relatively more normal tissue at its periphery. At a later stage, the involved tissue begins to liquefy and becomes demarcated at various points. In these areas it becomes separated from the wall of the abscess cavity. Subsequently the slough separates completely and itself liquefies entirely or in part. With the onset of initial liquefaction, spontaneous drainage and aeration through the communicating bronchi occur in varying degree. These phenomena depend not only upon the fluidity of the contents of the cavity but also upon the patency of the bronchi which open into the cavity. Bronchial patency is determined by the degree of inflammatory swelling of the bronchial mouths and the degree of their obstruction by exudate. If drainage and aeration via the bronchial tree are adequate and the anaerobic infection is controlled,

the lesion may heal spontaneously. If not the lesion becomes chronic in the vast majority of cases. Since our paper deals specifically with acute putrid abscess of the lung, the pathological features of the subacute and chronic phases will not be described.

#### FACTORS RESPONSIBLE FOR ROENTGENOGRAPHIC FINDINGS

Various gross pathological changes, which occur within the involved pulmonary area during the acute stage of the disease, have their counterpart in changes which are to be noted in the x-ray film. In general the roentgenographic features depend upon a combination of the following circumstances: (1) the size of the lesion, (2) its location, (3) the degree of infection present, (4) the degree of liquefaction which has occurred, (5) the degree of spontaneous drainage and aeration which has taken place via the bronchial tree, (6) the presence or absence of extension of the lesion beyond its original limits, (7) the extent and intensity of the overlying pleural reaction, (8) the presence or absence of perforation of the lesion into the pleura together with the degree and extent of the accompanying pleural response, (9) certain factors which are concerned with roentgenographic technique. Since each of the foregoing is variable, it is evident that combinations of them will result in roentgenograms with widely varying details. It is roentgenographic differences may exist not only between one case of acute putrid pulmonary abscess as compared with another but also between serial films in individual cases. All other factors remaining constant the time interval between the onset of infection and the taking of the roentgenogram is the factor chiefly responsible for the varied roentgen findings. Thus if comparisons are to be made between the findings in various cases it is essential that the films which are to be compared be taken at corresponding times following the onset of the disease.

In the individual case time is also the factor largely responsible for the changing roentgen picture. For example in the earliest phase evidence of cavitation is not to be noted in the roentgenogram. As necrosis and liquefaction progress however evidence of cavitation in one form or another generally appears. As will be pointed out later the time at which typical evidence of cavitation is noted varies considerably, and in some instances may be delayed far beyond the usual period.

While it is not our intention to discuss the treatment of acute putrid abscess of the lung, it is proper to stress the dangers of prolonged observation of patients pursuing an unsatisfactory clinical

ical course, in order to await the appearance of "typical" evidence of cavitation. Serious complications, which increase the morbidity and the immediate and ultimate mortality, may result from such undue delay of therapy. If the clinician realizes that "typical" evidence of cavitation is not the *sine qua non* of roentgen diagnosis and has a knowledge of the various roentgenographic features of the disease and their significance, he is in a position to corroborate the clinical diagnosis at an early stage and therefore to begin his therapeutic efforts promptly. As we have shown elsewhere (2, 3), operative treatment is especially important in the early stages of cases which are not progressing satisfactorily.

#### ROENTGENOGRAPHIC EXAMINATION

Films are taken upon admission of patient to the hospital and, if the clinical progress is satisfactory, at weekly intervals thereafter. If the clinical manifestations indicate an unfavorable course, or if the initial films suggest that early operative intervention may be desirable, films are taken more often. If, at any time, there is a rise in temperature, sudden cessation or marked diminution of expectoration, recurrence of pain in the chest, dyspnea, or the appearance of new or untoward physical signs or symptoms, immediate roentgen examination is imperative.

Films are taken routinely with the patient in the erect posture, placed carefully in the postero-anterior and then in the lateral position. Although slight rotation of the body out of the *exact* postero-anterior or lateral position as a rule makes little difference from the standpoint of diagnosis, it may result in inaccurate localization of the lesion. Since we are not concerned in this article with methods of localization, this phase of roentgenography shall not be discussed, but will be the subject of a separate communication in the near future.

There are several reasons for taking films routinely with the patient in both the postero-anterior and lateral erect positions. Postero-anterior films reveal the details of the vast majority of lesions clearly and in accurate proportions. Certain details not visible clearly in the postero-anterior view often are noted readily in the lateral view. At times single or multiple small fluid levels, visible when the patient is in the postero-anterior position, may not be seen with the patient in the lateral position (Figs. 11 and 12), and vice versa (Figs. 13 and 14). Very frequently accentuation of the interlobar fissures, the significance of which will be discussed later, will be indistinct or not seen at all in the postero-anterior film, while in the

lateral film it will be clearly discernible (Figs. 12 and 14). The details of lesions lying behind or in front of the heart or hilus of the lung may be more distinct in the lateral than in the postero-anterior film. On the other hand, lesions lying on either side of the heart, or immediately lateral to the hilus of the lung, or in the paravertebral region, may be more readily visible in postero-anterior than in lateral films. Finally, films taken with the patient in the erect position, in contrast with those taken in the recumbent or semi-recumbent position, are essential for the demonstration of fluid levels. Recumbent or semi-recumbent films are of little or no value for this purpose, because air situated above fluid cannot be demonstrated when the rays are directed in such a manner as to penetrate them in succession, that is from above downward.

The significance of a horizontal line of increased density, seen in the postero-anterior or lateral erect film and suggesting the presence of a fluid level, may have to be determined by a film taken with the patient in the lateral recumbent position, or in the erect position with the body well tilted to one side or the other. Under such circumstances the presence of a fluid level is established if the line under suspicion remains horizontal regardless of the patient's position. Oblique films, with the patient in the erect position, are of special value in those instances in which the area under suspicion tends to be obscured in the routine postero-anterior or lateral film. Thus, the details of a lesion lying in front of or behind the heart, or in close proximity to the sternum or vertebral column, are frequently clarified in an oblique film. Oblique films are occasionally of value when the lesion lies along the extreme lateral border of the chest, and thus tends to be obscured by the superimposition of the anterior and posterior curvature of the ribs. When the lateral film discloses a posteriorly situated lesion, certain details not entirely clear in the customary postero-anterior view may be more readily discernible in the anteroposterior position. With the patient in the latter position, the lesion lies closer to the film, there is less diffusion of the rays, and its image therefore is clearer. We do not employ stereoscopic films and wish again to emphasize that simple postero-anterior and lateral films taken with the patient in the erect posture, have sufficed for purposes of diagnosis, localization, and determination of the progress of the lesion, in the majority of instances.

#### ROENTGENOGRAPHIC FINDINGS

We now proceed to the presentation of roentgenographic findings in acute putrid abscess of the

lung. These are usually readily explainable on the basis of a consideration of the pathological changes, as described in previous paragraphs.

1 *The typical case.* The earliest roentgenographic feature, to be noted in the typical case, is the appearance of a small area of pulmonary infiltration. The latter is indistinguishable from a patch of bronchopneumonia of the usual variety, except that as a rule it is more sharply circumscribed, its margins more rounded, and its limits more clearly defined (Fig 2).<sup>1</sup> The infiltration usually becomes visible within a week of the onset of infection. The next phase consists of an increase in the density and in the extent of the infiltration. The third phase begins with the onset of visible evidence of necrosis and cavity formation (Fig 3). At this time, striking changes usually are to be noted in the roentgenogram. These consist in the occurrence of one or more small areas of increased illumination (diminished density) within the pre-existing area of infiltration, and are produced by softening and liquefaction of small foci within the area of gangrenous bronchopneumonia. As liquefaction continues, these multicentric areas of softening tend to coalesce. Frequently their coalescence can be followed in serial roentgenograms until the typical unilocular cavity is produced (Fig 4). Usually the major portion of the pre-existing area of pneumonic infiltration becomes progressively excavated and as a rule only a thin rim of infiltrated and compressed pulmonary tissue remains peripherally as the "wall" of the abscess cavity (Figs 5, 6, and 7). Within the cavity, a horizontal level of fluid surmounted by air is seen. With changes in the position of the patient, the fluid maintains its horizontal level. In the average case, the diameter of the cavity varies from 1 to 3 inches, and the width of the surrounding pulmonary infiltration from  $\frac{1}{4}$  to  $\frac{1}{2}$  an inch (Fig 9).

If drainage and aeration are adequate, the cavity becomes evacuated completely, the existing infection subsides and disappears, the surrounding narrow zone of pulmonary infiltration is absorbed and the cavity disappears. Subsequent films then reveal limited fine pulmonary fibrosis which either remains visible permanently or in time disappears completely. In general a lesion which heals spontaneously is usually of comparatively small size or is represented by an area of infiltration of comparatively slight density. Also as a rule, it passes fairly rapidly through the various phases of evolution and regression. Thus

in our experience, cases of acute putrid abscess of the lung which heal spontaneously usually regress completely or show a definite tendency toward regression well within the six week (acute) period. If by that time the tendency toward spontaneous resolution is not well established, the chances of its occurrence at a later date become increasingly remote. Accordingly we have found a sharp decrease in the number of cases which subside spontaneously, and a corresponding increase in morbidity and mortality during the subacute stage (6 to 10 weeks). During the chronic stage spontaneous subsidence practically never occurs.

2 *Variations.* A not uncommon variant from the typical picture as described is one in which the lesion is unusually large. As stated previously, the average acute abscess varies from 1 to 3 inches in diameter. In some cases the lesion exceeds this size and on not a few occasions we have noted abscesses 4, 5 and even 6 inches in diameter. Excavation in these cases proceeds as rapidly and at times even more rapidly than in the typical cases (Figs 5, 6, and 7). Because numerous bronchi in the involved area undergo necrosis, large abscesses often drain and ventilate fairly freely. They therefore appear in the roentgen film as large air-filled cavities containing comparatively small amounts of fluid and surrounded by zones of pulmonary infiltration of varying width. Not infrequently, because of its large size, the differentiation of such a lesion from perforated abscess with associated encapsulated pyopneumothorax is extremely difficult or impossible. While large abscesses conceivably may subside spontaneously at times the patients usually have been so toxic and the uncertainty of the coexistence of a complicating putrid pyopneumothorax so great that we have been unwilling under such circumstances to defer operation.

Although pulmonary cavitation as stated previously occurs early in cases of putrid abscess, the typical roentgenographic evidence of cavitation, namely a circular area of rarefaction with fluid level, varies considerably in the time of its appearance. Thus, in some cases the cavity becomes visible in the roentgenogram almost as soon as cavitation occurs, while in others it may not be visible for days or even weeks. In still other cases a cavity may not be seen during the acute stage, and finally in others a cavity may never be noted even in the subacute or chronic stage. Likewise the amount of fluid to be noted within the cavity varies considerably.

3 *Fluid levels and cavities.* As indicated in the section on pathology, the presence or absence of a cavity containing fluid and air in the roentgeno-

FIGURES 1, 2, 3, and 4 illustrate the evolution of an acute putrid abscess of the lung in graph column next figure. Reproduce film if chest taken seven days before the patient developed the pulmonary abscess. We are indebted to Dr. William L. W. for the use of these films.

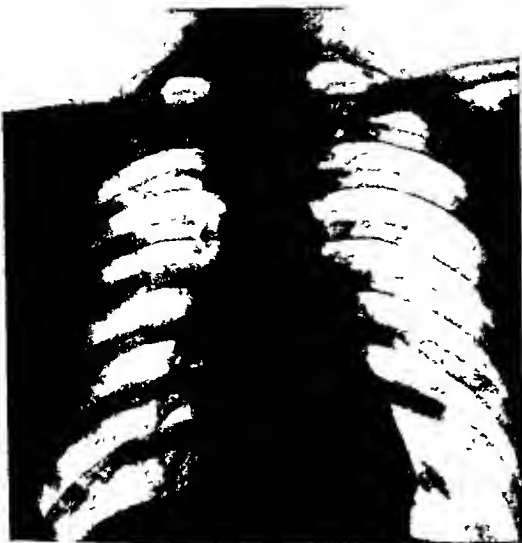


Fig 1 W R Routine film of the chest which was taken before laryngectomy was performed. The roentgenogram discloses no abnormalities.

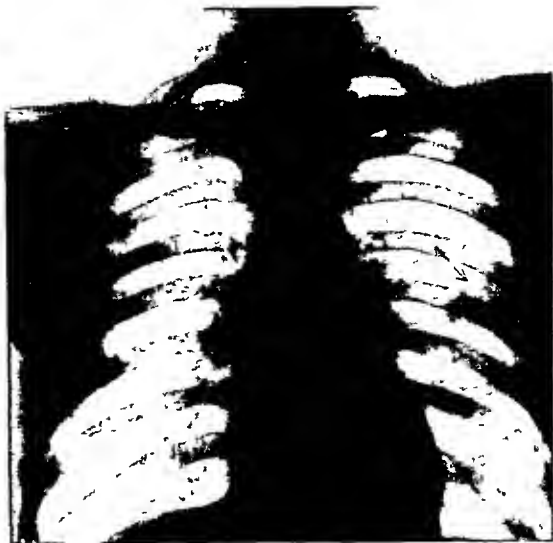


Fig 2 W R Eleven days after onset of postoperative pulmonary abscess (very early phase). Small area of infiltration in axillary segment of left pulmonary field.

gram is an accident which depends upon the degree of spontaneous drainage of fluid secretion through the communicating bronchi, and its re-

placement by air. If drainage is free, the cavity on x-ray examination contains little or no fluid. On the other hand, if the communicating bronchi are

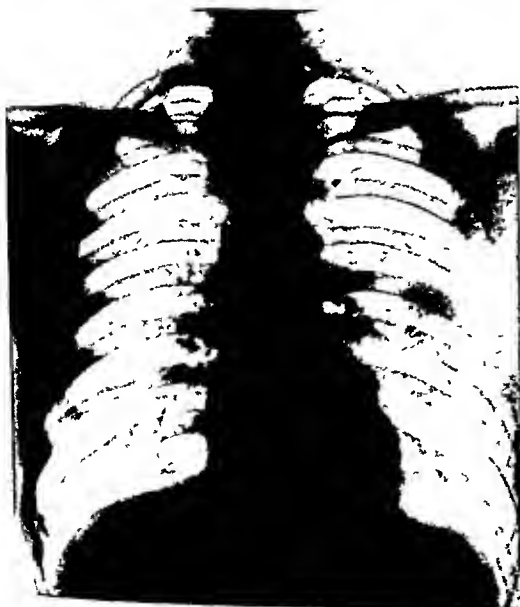


Fig 3 W R Same case as in Figures 1 and 2. Seven days later. Increase in density and extent of pulmonary infiltration (sixth to eighth ribs), and beginning cavitation beneath sixth rib.

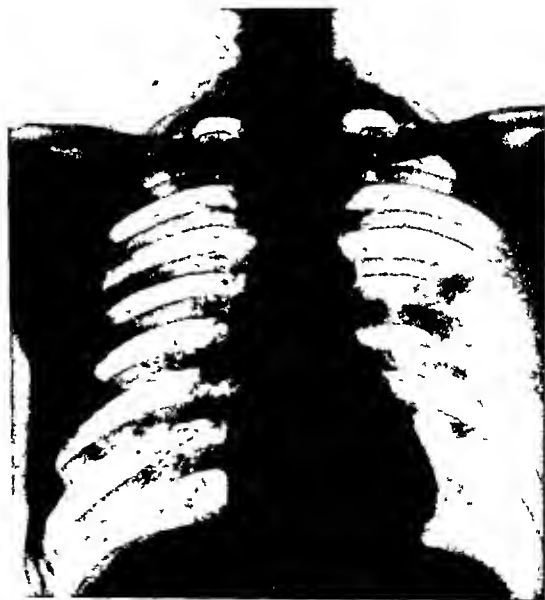


Fig 4 W R Six days after Figure 3. Large area of dense pulmonary infiltration (fifth to eighth ribs), containing a cavity with small fluid level. Film indicative of inadequate spontaneous drainage. Unsatisfactory clinical course.



Fig. 5 J. R. Early phase in the development of a large abscess of lung. Infiltration extends from the ninth rib downward. Enlarged hilar glands are present. This is a typical case.



Fig. 6 J. R. Eight days later. Pulmonary infiltration replaced by a large cavity containing fluid and air. Limited pulmonary infiltration about cavity. Irregular contour of cavity indicating early peripheral extensions.

completely obstructed by inflammatory edema or by detritus, none of the contents of the cavity can escape and no air can enter. Under such circumstances the shadow cast by the filled cavity merges with and is indistinguishable from, that of the

surrounding pulmonary infiltration. Thus in some cases the typical roentgenographic evidence of cavitation may not be visible despite the actual existence of a large cavity within the lung (Fig. 6). In other words, at times the presence of 'premonitory' infiltration may indicate not an absence of cavitation but an abscess cavity completely



Fig. 7 J. R. Same case as in Figures 5 and 6. Lateral view (same time as Figure 6). Sharp limitation of lesion and minimal surrounding pulmonary infiltration.



Fig. 8 M. E. Dense pulmonary infiltration in right paravertebral area without evidence of cavitation. At operation a large abscess was encountered.



Fig 9 M K Well defined abscess of average size Small fluid level indicating free drainage Moderate surrounding pulmonary infiltration

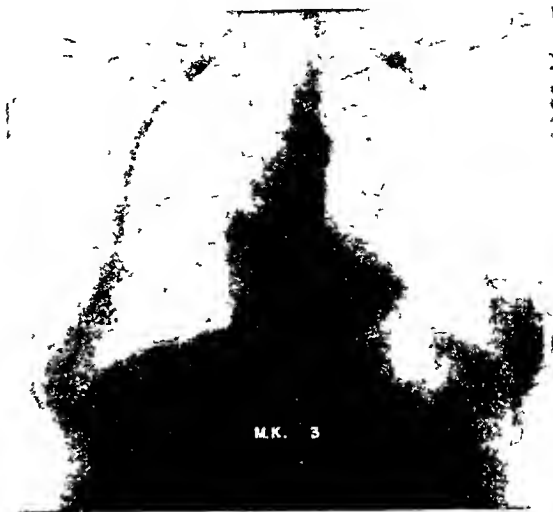


Fig 10 M K Same case as Figure 9 One day later Cavity filled with pus because of inadequate drainage Increase in density of entire lesion

filled with pus and detritus. Between the extremes of free drainage on the one hand and total absence of drainage on the other, all gradations and variations in the degree of spontaneous drainage exist.

After spontaneous drainage and aeration have begun, the roentgen evidence of the existence of a cavity may vary from a tiny fluid level surmounted by a small bubble of air (Fig 13) to an air filled cavity containing either no fluid or a small amount of fluid (Fig 9). It should be emphasized that the patency of the communicating bronchi may vary considerably from time to time and that a lesion which is draining well at one time may drain poorly or not at all at a later date. The result of such a sequence is a roentgenogram disclosing a cavity containing a well defined fluid level, followed by one in which the cavity apparently has diminished considerably in size or has disappeared in the midst of the surrounding pulmonary infiltration (Figs 9 and 10, 15 and 16). If spontaneous drainage and aeration become re-established at a later stage, the cavity reappears, its size then depending upon the degree of drainage and aeration.

Other roentgenographic variations are to be noted at times in cases in which spontaneous drainage and aeration are inadequate. A fairly common type is one in which a cavity of small or moderate size is surrounded by an extensive zone of dense infiltration (Figs 4, 13). In another type, multiple small areas of increased illumination (diminished density), with and without contained fluid

levels, are to be noted within an area of extensive infiltration (Figs 11 and 17). And finally, as stated previously, a common type is one in which only dense infiltration alone is visible (Figs 8, 10, and 16).

4 *Spread of infection* If drainage remains poor or ceases entirely, the lesion either remains unchanged in extent for a variable period of time or else commences to enlarge. In the latter instance, there is first an increase in the extent of the infiltration. This may occur in concentric fashion or may take place at one or more points at the periphery of the original lesion. As fresh invasion of pulmonary parenchyma occurs, the newly involved area undergoes pathological changes which are identical with those of the primary lesion (Figs 16 and 17). Not infrequently, some drainage and aeration of the entire involved area may occur as the result of the erosion of a previously uninvolved bronchus (or bronchi), and as a result an irregular multilocular cavity consisting of the original abscess together with the recent extensions may become visible in the roentgenogram. The ultimate fate of such a lesion depends apparently, as in the first instance, on the degree of evacuation and aeration via the communicating bronchi.

In addition to spread of pulmonary infection by direct extension from the original site into the surrounding uninvolved pulmonary tissue (Figs 16 and 17), new infection may occur by the mechanism which we have termed "spillover." The latter type of spread results from the aspiration of anaerobically infected pus, derived from the bronchi



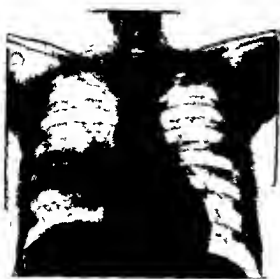


Fig. 11. A. J. Large abscess of right lung 1 week after onset. Multiple areas of rarefaction (with and without fluid levels) within the zone of pulmonary infiltration. Film indicative of incomplete liquefaction. Septic clinical state.

draining the abscess cavity, into previously uninvolvement bronchi. As the result of such inoculation of new bronchopulmonary segments gangrenous bronchopneumonia similar to that which occurred at the onset of the original abscess, is to be noted. These "spillover" lesions may occur within the same lobe adjacent lobes, or the opposite lung. If "spillover" infection occurs within the same lobe, it may be indistinguishable roentgenographically from spread by direct extension because of the proximity of the old and the new lesions.

Spillover infection to other lobes or to the opposite lung, is readily recognized by virtue of its distance from the original lesion (Fig. 18). From the clinical and roentgenographic standpoint the fate of the fresh spillover lesion varies in accordance with certain circumstances which were detailed in preceding paragraphs. Unfortunately spillover infection frequently involve such a large area that the patient often succumbs from the toxic effects of fresh gangrenous bronchopneumonia before the occurrence of extensive cavitation.

5. *The associated pleural reaction.* A roentgenographic feature of interest in cases of acute putrid pulmonary abscess is the associated pleural reaction. We are now discussing specifically only cases of acute abscess which have not perforated into the pleura. It was indicated previously that adhesive pleuritis occurs invariably directly over the site of an acute abscess. The adhesions are situ-



Fig. 12. A. J. Lateral view (same time as Figure 11). Details of lesion are not seen. Accentuation of oblique and transverse interlobar fissures. Abscess lies in apex of lower lobe close to the junction of these fissures.

ated most commonly between the lung and the thoracic parietes but occasionally between the lung and the diaphragm or mediastinum. At times the situation of the lesion may result in the formation of adhesions only between two adjacent lobes. The pleuritic response is dependent upon the irritative effect of the abscess the most superficial portion of which lies close to the overlying visceral pleura. Other factors being constant the extent of the pleuritis is proportionate to the size of the lesion. By the same token adhesions will be most dense in the area in which the lesion most nearly approaches the surface of the lung. This in cases in which a well defined cavity surrounded by comparatively little pulmonary infiltration is visible on x ray examination the pleural reaction as disclosed at operation usually does not extend far beyond the limits of visible cavitation. On the other hand when a comparatively small cavity exists in the midst of a wide zone of pulmonary infiltration the pleural reaction extends not only over the site of visible cavitation but also approximates to the limits of the pulmonary infiltration (Fig. 17).

At times the pleural reaction appears to be unusually dense and to extend well beyond the



Fig 13 M W Area of dense pulmonary infiltration in axillary segment of left lung. Solitary cavity, apparently small. Film indicative of inadequate drainage.



Fig 14 M W Lateral view (taken at same time as Figure 13). Multiple cavities containing fluid levels, not visible in postero-anterior view (Fig 13). Accentuation of upper part of interlobar fissure and widening of lower part. Pulmonary lesion in upper lobe facing fissure.

area of pulmonary involvement. This is most apt to occur when the abscess offers roentgenographic evidence of inadequate spontaneous drainage, as shown by the existence of dense pulmonary infiltration alone or by infiltration containing single or multiple small areas of increased illumination with or without small fluid levels. Dense and extensive pleural reaction is to be regarded seriously, as not infrequently it is an indication of impending or actual perforation of the lesion into the pleura. When spontaneous drainage and aeration are inadequate, peripheral spread of infection is particularly apt to occur, and the thin shell of lung overlying the abscess becomes invaded by the advancing infective process. Under such circumstances, rapid spread of the adhesive pleuritic reaction may be assumed. While it is not our purpose in this paper to describe the general roentgenographic features of perforated abscess, attention should be called to the fact that under certain circumstances localized perforation of a pulmonary abscess into the pleura may exist without producing significant changes in the roentgenogram. Thus, in cases in which there is roentgenographic and clinical evidence of inadequate spontaneous drainage and aeration via the bronchial tree, and the overlying pleural reaction is dense and extensive, perforation into the existing pleuro-pulmonary adhesions may have occurred. Since the bronchi which open into the abscess cavity in such cases are not widely patent (as evidenced by absence of a fluid level within the area of infiltration), a small empyema rather than a pyopneumo-

thorax (which is the usual roentgen sign of perforation of abscess of the lung into the pleura) is produced. Because of the extent and density of the pre-existing pleural reaction, such small empyemas may not be recognizable in the x-ray film. Thus, as reported in a previous communication (3), actual local perforation into the pleura which was not known to exist before operation, was found at operation in several instances. On the other hand, at times pleuritic response may be so well marked that local perforation into the pleura may be suspected yet be absent at operation.

**6 Interlobar fissures.** Another interesting and significant roentgen finding, in certain cases of acute abscess of the lung, is the accentuation of interlobar fissures. As stated previously, putrid pulmonary abscess, because of its situation superficially within a lobe, is accompanied regularly by reaction in the overlying pleura. When a pulmonary abscess lies in close proximity to one of the fissures, the overlying pleural reaction may occur exclusively within the fissure and agglutinate the surface of the involved lobe to the surface of an adjacent normal lobe. In such unusual cases, at operation, adhesions between the lung and tho-



Fig. 15 S-M Dense infiltration containing a cavity with fluid level in left upper lobe. Irregularity of cavity indicating further invasion.



Fig. 16 S-M Same case as in Figure 15. Several days later. Disappearance of cavity as a result of inadequate drainage.

racic parietes usually are absent or minimal. The occurrence of pleural reaction within one of the



Fig. 17 S-M Same case as in Figures 15 and 16. One week after Figure 16 was taken. Further proof of disease indicated by increase in density, extent of pulmonary infiltration and pleural reaction. Original cavity not visible. Several new areas of rarefaction in lowermost part of infiltrated area.

fissures is indicated roentgenographically by the presence of a line of opacity occupying the portion of the fissure in question. Such opaque lines are not seen in normal pulmonary fields.

The degree and extent of fissural accentuation as noted in the x-ray film is directly proportional to the degree and extent of fissural pleuritis. A pulmonary abscess of the upper or lower lobe facing a point along the lower part of the long (oblique) interlobar fissure, usually is associated with accentuation of the lower part of the fissure only. A lesion facing the upper part of the fissure is accompanied by accentuation of this portion of the fissure and frequently by accentuation of the lower portion as well as the result of downward seepage of exudate (Fig. 14). On the right side a lesion of the upper or middle lobe facing a point along the short (transverse) fissure usually is associated with accentuation of this fissure. Finally, both the oblique and transverse fissures may be accentuated by a lesion lying at a point close to the junction of the fissures within either the upper, middle or lower lobe (Fig. 12). In all cases of irritative accentuation the fissure appears as a thin well defined line of increased density. In some instances it is represented by a more dense and somewhat wider line indicative of more severe pleuritic reaction. This occurs commonly in cases in which an abscess of one lobe has perforated across the sealed-off fissure into an adjacent lobe.

or in cases in which such perforation is imminent. In still other cases, the interlobar fissure may be represented by a fairly wide zone of density indicative of interlobar effusion or exudate (Fig 14). This may be the result of impending or actual perforation of a pulmonary abscess into the fissure, in cases in which the lobes have not become firmly agglutinated. Although accentuation of the fissures may be visible in both the postero-anterior and lateral films because of limited superimposition of pulmonary tissue, it is best seen in the lateral film. Thus fissural accentuation not visible in the postero-anterior film may be seen readily in a lateral film taken at the same time.

#### ROENTGENOGRAPHY AS AN INDEX OF THE COURSE OF THE DISEASE

After the diagnosis of acute pulmonary abscess has been established, the clinical manifestations and the roentgen findings continue to be an index of the progress of the lesion. There are times, however, when the evidence gained from these two sources appears to be in conflict. The question then arises, which is to be considered the more important and upon which the greater reliance is to be placed in the evaluation of the status of the patient. For example, in the majority of "typical" cases of acute putrid abscess, the symptoms become ameliorated as spontaneous drainage and aeration are established. Thus at the end of 2 to 3 weeks, the temperature is apt to be lower and the sputum not infrequently diminishes in amount. At that time the sputum may become less foul, may be foul only at intervals, or may become entirely odorless. If the x-ray film reveals diminution in the size of the cavity and in the extent of infiltration, the assumption that improvement is taking place is warranted. On the other hand, if the roentgenogram reveals increase in the size of the cavity and persisting or increasing pulmonary infiltration, the mildness of the clinical manifestations must be disregarded. This dictum cannot be emphasized too strongly, since some of our patients with chronic abscess of the lung previously had been discharged by their physicians as cured in the acute phase of the disease, although roentgenograms taken at that time revealed persisting pulmonary infiltration. Thus, "cure" cannot be considered to have taken place, regardless of the subsidence of clinical manifestations, unless roentgen evidence of pulmonary infiltration has disappeared completely.

At times, clinical manifestations may become more severe concomitant with apparent roentgenographic improvement. Under such circumstances, the observer may be unable to decide



Fig 18 P M Acute "spillover" abscess of right upper lobe following recent operation upon subacute abscess of left lower lobe. Infiltration in right upper lobe containing a cavity with fluid level just above sixth rib. Residual infiltration at site of operation in left lower lobe.

which of these criteria to utilize in evaluating the patient's status. We wish to state that such a discrepancy can be due only to an error of roentgen interpretation. The mistake which usually is made is the assumption of improvement on the basis of disappearance of a cavity in the roentgen film despite the persistence of pulmonary infiltration. As stated previously, this sequence is common when spontaneous drainage and aeration become inadequate, for under such circumstances the cavity within the lung, which seemingly disappears, merely becomes invisible because it is filled with secretion (Figs 9, 10, 15, and 16). Proof that the lesion has become "shut-off" from the bronchial tree often is offered by alteration of the clinical manifestations. Thus, the sputum may decrease sharply in amount and lose its foul odor entirely or in part. The temperature, however, is apt to be higher, the pulse rate to increase, and the patient to look and feel more ill. If peripheral spread of the lesion follows, there is apt to be a recrudescence of thoracic pain and of hemoptysis. Thus, when the clinical course is unsatisfactory, the very existence of an apparent discrepancy between clinical symptomatology and roentgenography should lead to the suspicion of an error in interpretation of the roentgen film.

A consideration of the relative value of these two criteria of progress of the lesion leads therefore to the conclusion that roentgenography, when the findings are interpreted correctly, is as reliable as, and at times more reliable than, the symptomatology. From the standpoint of reliability in

instances in which the question of cure is considered we can only state again that experience has demonstrated on numerous occasions that, regardless of the complete absence of clinical manifestations no patient can be considered cured until all pulmonary infiltration has disappeared.

#### SUMMARY AND CONCLUSIONS

This contribution is based upon observations made in a series of more than 150 cases of acute putrid pulmonary abscess. In 65 cases operation was performed in the acute stage of the disease. Thus there was ample opportunity to correlate operative findings with pre operative roentgenograms.

The diagnosis of acute putrid pulmonary abscess rests both upon clinical features and roentgenographic findings. The disease *cannot* be diagnosed solely by roentgenography. The latter is, however, a diagnostic method which is absolutely essential for corroboration of the clinical diagnosis. Roentgenography is the most important method for accurate localization of the lesion. It also serves as an index of the course and prognosis of the disease.

The pathological features and the factors responsible for the varied roentgenographic appearances in acute putrid pulmonary abscess are presented.

Methods of roentgenographic examination with special reference to demonstration of the pulmonary lesion are described.

In the evolution of the typical case of acute putrid pulmonary abscess early roentgenograms reveal only the presence of a limited area of pulmonary infiltration. The latter increases in extent and density in the second stage. Rarefaction

within the involved area occurs in the third stage. The fourth stage is one of progressive evacuation of this area. The cavity contains air and fluid and is surrounded by limited pulmonary infiltration.

Among the roentgenographic variants which are discussed are: Unusually large size of the abscess; rapid increase in size of the lesion; variations in the time of onset of cavitation; absence of evidence of cavitation; early multilocularity; widespread pulmonary infiltration with and without cavitation; sudden disappearance of cavities; extensive pleural reaction; evidence of spread of infection by direct extension or by "spillover."

The pleural reaction accompanying acute pulmonary abscess and its variations are described with special reference to roentgenographic aspects. The significance of accentuation and other abnormalities of the interlobar fissures are discussed.

The greater reliability of roentgenography as compared with clinical manifestations as an index of the course of acute pulmonary abscess, is stressed. Emphasis is placed upon the necessity of correct roentgen interpretation when apparent roentgenographic improvement is noted in the presence of an unsatisfactory clinical course.

#### BIBLIOGRAPHY

1. CLARK, A. The bronchopulmonary segment with special reference to putrid lung abscess. *Am J Roentgenol* 1934 37: 338.
2. ALLUOR, H. and TUCKER, A. S. W. Acute putrid abscess of the lung: principles of operative treatment. *Surg Gynec & Obst* 1936 63: 353.
3. Idem. Acute putrid abscess of the lung: an analysis of forty five consecutive operative cases. *Surg Gynec & Obst* 1938 66: 8, 9.
4. TUCKER, A. S. W. and MOULTON, S. E. The symptomatology of putrid abscess of the lung. *J. Thorac Surg* 1935 4: 358.

# OPERATIVE MANAGEMENT OF FIBROMYOMAS IN THE UTERUS AT TERM

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**P**REGNANCY is infrequently accompanied by fibromyomas of the uterus, and these tumors require operative interference even less often during pregnancy, labor, and the puerperium. Active controversy concerning the choice of myomectomy or hysterectomy for those requiring treatment after viability of the fetus and in the puerperium is well illustrated by the conflicting statements in the literature. Therefore, this present study was undertaken to evaluate better the relative merits of each

## LITERATURE

In several large series of pregnant patients the frequency of fibroid tumors varies from 0.3 per cent (2) to 1.4 per cent (10) with the average incidence being near 0.5 per cent (1-4, 7, 10). In the majority of such cases the fibroid does not interfere with the usual course of pregnancy, delivery, or the puerperium. Many times the nodules are findings which are accidentally discovered when the uterus is palpated during labor or the puerperium. The size, position, type, and number of tumors are the significant factors.

Submucous, large subserous, and intramural fibromyomas are often responsible for sterility and for an increased incidence of complications in pregnancy. Abortion and premature labor may result. However, an equally serious problem is offered by the fibroid tumor which is of sufficient size or so located that it may produce obstruction to the passage of the fetus through the birth canal. Less than one-half of the fibroids complicating pregnancy are of this type but they, nevertheless, offer a distinct problem in the management of parturition. Degenerative changes or infection in the tumor are also of serious import.

The usually accepted plan for treatment of fibroids during pregnancy consists of careful observation without interference unless symptoms of sufficient magnitude arise. In such instances, myomectomy may be done before fetal viability, for one or a few readily accessible nodules if the product of conception remains undisturbed. Abortion occurs frequently subsequent to this type of

operative interference. Hysterectomy is a preferable procedure for multiple and inaccessible tumors, for unsatisfactory hemostasis following myomectomy, or for a seriously damaged uterus.

At the end of gestation obstetricians generally agree that the following possibilities must be considered in deciding the method of delivery:

(1) Even if the birth canal is unobstructed and vaginal delivery seems probable, the fibroid may be associated with inadequate or faulty uterine contractions enough to prolong labor dangerously.

(2) The tumor may offer unrecognized obstruction to the passage of the fetus. For these reasons, the early part of labor should be considered in the light of a trial labor and not as a commitment to vaginal delivery.

(3) The presence of the fibroid tumor increases the frequency of vaginal operative interference.

(4) Complications of the third stage of labor are more frequent as has been shown by Campbell's report of postpartum hemorrhage (600 cubic centimeters) in 31.7 per cent and adherent placenta in 9.7 per cent of his series.

(5) Although vaginal delivery may be accomplished without difficulty, degenerative changes in the fibroid may still necessitate operative interference during the puerperium. Necrosis was present in 75.8 per cent of fibroid tumors in 82 pregnant patients (Campbell). This is almost ten times greater than the incidence of 7.8 per cent, in the non-pregnant state.

When cesarean section is the method used for delivery it may be done alone, combined with myomectomy, or followed by hysterectomy. When it is the only procedure the risk of postpartum hemorrhage and necrobiosis persists, and the fibroid still remains as a source of morbidity. Myomectomy in conjunction with cesarean section may remove the more prominent tumors, but others may develop subsequently. A more immediate danger is hemorrhage through inadequate or unsatisfactory hemostasis and infection in the operative site. Removal of the uterus should decrease the danger of infection and at the same time prevent further trouble from enlarging fibromyomas. Of course, extirpation of the uterus excludes future childbearing.

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TABLE I.—CESAREAN SECTION

Author	Total cases	Fibroids reported		Cesarean with hysterectomy		Cesarean with myomectomy		Cesarean only		Hysterectomy in p. perium		Myomectomy in p. perium	
		Opera- tions	Deaths	No.	Deaths	No.	Deaths	No.	Deaths	No.	Deaths	No.	Deaths
Kustoor (Le P. g.) 1933	15 600	6	0	9	0	3	0	7	0	1	0	2	0
Eissman (Pittsburgh) 1934	23 000	23	0	5	0	10	0	0	0	0	0	0	0
Mooney & Hardwick (Mayo Cl.) 1935	5 600	25	0	0	0	0	0	6	0	0	0	0	0
Watson (Sloane N. Y.) 1935	11 676	25	1	0	1	0	0	0	0	0	0	0	0
Person (Sloane N. Y.) 1937	30 836	30	5	19	0	0	3	0	0	0	0	2	0
Lantuejoul (France) 1935	?	9	0	0	0	4	0	0	0	3	0	1	0
Kosmak (New York) 1935	33 266	23	0	0	0	0	0	11	0	0	0	0	0
Vaudesal (France) 1935	?	11	0	6	0	0	0	0	0	3	0	3	0
Campbell (Johns H. sp. 1933)	37 870	13	1	6	0	1	0	0	0	1	0	5	1
Spencer (England) 1930	?	7	1	6	0	1	1	0	0	0	0	0	0
Haber & Hensel (Chicago Lyng in Hospital)	20 095	11	1	8	0	1	1	0	0	1	0	0	0
Totals	18 141	164	8	50	1	50	5	9	0	17	0	10	1

\*Number of myomectomy and hysterectomies not stated

\*\*Death may have followed hysterectomy, myomectomy, or cesarean section alone—unstable

## ANALYSIS OF DATA

Controversy is evidenced by conflicting recommendations in the choice between myomectomy and hysterectomy at the time of cesarean section. In order to obtain a better evaluation of these two types of therapy, pooled data were used to eliminate errors in individual smaller series. To obtain a balanced report, it was deemed advisable to use only those in which a series of cases was published as the numerous isolated case reports almost invariably represent a favorable termination which might thus give a false value. The 10 reports meeting these requirements, published since 1920, are presented in Table I. Due to the improvement in pre-operative and postoperative care and management in recent years, it was believed that earlier studies might well be excluded. These quoted reports offer a significant number of cases and also contain adequate information concerning the associated mortality. In addition, operative procedures in the immediate puerperium are included. Including the report from the Chicago Lyng in Hospital department of obstetrics and gynecology, The University of Chicago, 8 of the 11 sources have cared for 182,543 obstetric cases. The total deliveries covered by the 3 other reports is not given but certainly represents a proportionately greater number. In this pooled group the fibroid was of sufficient significance to warrant abdominal delivery in 131 cases. In 23 additional instances operative treatment of the fibroid tumor subsequent to vaginal

delivery was necessary during the course of the puerperium.

Cesarean section alone was done in only 18 cases, all of which are reported by 3 of the authors (3, 4, 6) listed in Table I. No deaths are recorded. The one death (3) not definitely assigned to the separate procedures may have been in this group as noted in Table I. It is interesting to note that in over 115,000 cases analyzed by the 8 remaining authors (1, 2, 5, 7-10) cesarean section alone was not done.

Cesarean section was followed by hysterectomy in 59 cases. In this group there was one death recorded and in the one instance indicated in Table I it could not be determined whether the recorded mortality was in the hysterectomy group or subsequent to myomectomy. Even if we assume that both of these deaths occurred in the hysterectomy series, the maximum mortality percentage would be 3.4 per cent.

Myomectomy was performed in conjunction with cesarean section in 39 cases. Five deaths are definitely recorded in this group and if the designated case occurred in this group, the total is raised to 6. The mortality rate is then at least 15.4 per cent and may have been as much as 15.4 per cent.

The difference in the mortality in these two groups is so great that the probable error in relatively small series does not account for the variation. In addition, it is a fair assumption that myomectomy was done on those patients

TABLE II—CHICAGO LYING-IN HOSPITAL—MAY 25, 1931, TO JANUARY 1, 1938—DELIVERIES—20,895

A. Cesarean with hysterectomy			Gestation	Morbidity	Mortality	Fetal mortality	Remarks
Unit No	Age	Parity					
142631	43	0	40 wks	0	0	0	Hyalinized fibroid
164242	36	3	30 wks	0	0	Neonatal	Necrosis with pain
159863	33	1	40 wks	0	0	0	
120532	39	0	40 wks	Yes	0	0	
113300	41	0	40 wks	0	0	0	1,700 cubic centimeter blood loss
95435	31	0	38 wks	Yes	0	0	Iliac thrombosis with pulmonary embolism
73426	35	0	30 wks	Yes	0	0	16 hours premature labor
38662	35	0	39 wks	Yes	0	0	Pulmonary infarction—1200 cubic centimeter blood loss
B Cesarean with myomectomy			Gestation	Morbidity	Mortality	Fetal mortality	Remarks
Unit No	Age	Parity					
172284	33	0	39 wks	Yes	Yes	0	Pentometris
63178	32	0	40 wks	Yes	0	0	Septic course
C Hysterectomy during puerperium			Gestation	Morbidity	Mortality	Fetal mortality	Remarks
Unit No	Age	Parity					
175896	34	0	37 wks	Yes	0	0	Operation 36 hours postpartum—degeneration of intramural fibroid

whose tumors appeared least difficult of removal. It seems only just then to conclude that at the time of cesarean section hysterectomy is a safer procedure than myomectomy.

Further evidence for this statement is found in the fact that 13 hysterectomies were done in the puerperium without mortality whereas one fatality occurred in 10 myomectomies.

In the 20,895 patients who have been delivered at the Chicago Lying-in Hospital (Table II) from May 25, 1931 to January 1, 1938, 10 patients have had fibroid tumors of a nature to interfere with delivery, or an incidence of .05 per cent. In this group Porro cesarean section was done 8 times and cesarean followed by myomectomy in 2 instances. The 1 death occurred in the myomectomy group.

A consideration of morbidity in the two groups shows that in 4 of the 8 Porro cesarean sections the temperature was above 100.4 degrees on 2 or more days postpartum. This was true of both cases in which myomectomy followed cesarean section. In the hysterectomy group 2 of the morbid patients had evidence of pulmonary embolism and both recovered. In one of the others there was marked necrosis of the tumor and in the fourth the operation was performed after 16 hours of labor.

Both of the patients upon whom myomectomy was performed had definitely septic courses with chills and fever. The patient who recovered had a uterine infection.

The patient who died was a 33 year old primipara upon whom an elective cesarean section was done at 39 weeks

because of the presence of a large fibroid (10 by 12 by 8 centimeters) situated deep in the pelvis arising from the left and posterior uterine wall. Laparotrachelotomy was performed under local infiltration anesthesia (novocain  $\frac{1}{2}$  per cent) until the birth of the baby after which general anesthesia (cyclopropane) was used. The fibroid tumor was removed easily without entering the uterine cavity. The incision was readily closed. After operation the patient developed evidence of infection, ran a septic course, and died on the tenth day after operation. Necropsy disclosed a generalized peritonitis with evidence of intra-uterine infection extending through the myomectomy incision.

In addition, hysterectomy subsequent to vaginal delivery was performed once during the puerperium.

The hysterectomy in the puerperium was performed 36 hours after delivery because of extreme pain over the uterus, an elevation of temperature to 100 degrees, and a white blood count of 30,000. The delivery had been without incident following a normal labor and was accomplished by low forceps with episiotomy. Necrosis was present in a large intramural fibroid.

A condensed summary of all the operative procedures is presented in Table III. When one considers the inadequacy of cesarean section alone as a therapeutic measure in this situation, one feels that it is indicated only in the rare instance in which there is a definite contra-indication to more

TABLE III

Operation	Number	Mortality	Per cent
Cesarean only	18	0-1*	0-5.5
All hysterectomies	72**	1-2*	1.4-3.4
All myomectomies	49**	6-7*	12.2-14.3

\*One undesignated death may have occurred in any of the 3 groups.

\*\*An additional 15 cases as noted in Table I had either hysterectomy or myomectomy—unstats.



extensive operative treatment. The results in the hysterectomy group are definitely superior to those in the myomectomy series. This study, therefore, indicates that when abdominal operation is indicated hysterectomy is the better procedure for treatment of the fibromyomas. On the other hand, the mere presence of fibromyomas does not necessitate either hysterectomy or myomectomy.

#### CONCLUSIONS

In the treatment of the pregnant patient with uterine fibromyomas the following management is advised:

1. There should be careful observation during the course of pregnancy without interference unless symptoms of sufficient magnitude arise.

2. Natural delivery should be allowed to go on unless the size, number or location of tumors produces obstruction to the passage of the fetus.

3. Trial of labor should be permitted in doubtful cases.

4. When operative interference prior to delivery is indicated by necrosis in the tumor by

obstruction to the birth canal, or by failure of normal uterine mechanism, it should consist of cesarean section with hysterectomy.

5. If operative interference becomes necessary during the puerperium, hysterectomy is also the procedure of choice.

6. Myomectomy with cesarean section carries an appreciably greater mortality and therefore its employment is generally contra indicated.

7. Fibromyomas *per se*, do not necessarily indicate either hysterectomy or myomectomy.

#### BIBLIOGRAPHY

- 1 CAMPBELL, R. E. *Am J Obst & Gynec* 1935 26:1
- 2 FISAMAN, J. R. *Am J Obst & Gynec* 1934 28:519
- 3 KOSMAK, G. W. *Am J Obst & Gynec* 1935 6:15
- 4 KESTNER H. *Zentralbl f Gynaek* 1933 5: 851.
- 5 LANTÉJOIR, P. *Bull. de Soc. d'obst et gynec* 1933 24: 275.
- 6 MESSEY, R. D. and HARDWICK, R. S. *Am J Obst & Gynec* 1935 29: 102.
- 7 TIERSON, R. V. *Am J Obst & Gynec* 1927 14: 333.
- 8 SPENCER, H. R. *Lancet* 1920 1: 411.
- 9 VAN DESCAL, K. *Brit M J* 1928 2: 93.
- 10 WATSON, W. P. *Am J Obst & Gynec* 1932 21: 351.

# JEJUNOPLASTY

## For Obstruction Following Gastro-Enterostomy or Subtotal Gastric Resection

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**O**BSTRUCTION following gastro-enterostomy or subtotal resection of the stomach with gastrojejunal anastomosis occurs in a relatively small percentage of cases, but when it does it is a serious and frequently fatal complication. Almost every experienced surgeon with an accurate and retentive memory can recall such patients of his own, and others whom he has seen in consultation. It is noteworthy that nearly every senior house surgeon, notwithstanding that he has had special training and expert supervision, is likely to have one or more patients with this fatal complication. In one of our leading hospitals there have been only 1 or 2 exceptions to this record covering a period of 20 years. Graham reported 3 fatal cases following gastro-enterostomy and one other after a gastroduodenostomy. Moreover, such highly skilled surgeons as Marshall and Kiefer, of the Lahey Clinic, have largely abandoned the postcolic anastomosis in favor of the antecolic route following gastrectomy, apparently because of the frequency of obstruction. No percentages are recorded. The data available in our vital statistics on this subject are of little value, as the cause of death is often attributed to the original condition, commonly ulcer or cancer, or to the secondary complicating factors, such as paralytic ileus, peritonitis, pneumonia, myocardial failure, etc., when death was, in fact, the result of obstruction. The contention so frequently advanced, that obstruction would not occur if the operation had been done properly, is beside the question. None will deny that experience makes all complications less common. Not infrequently, however, the "master surgeon" has attained his enviable state of skill and balanced judgment through such bitter experience and disappointment.

### CAUSES OF OBSTRUCTION

Obstruction after posterior gastro-enterostomy may be due to one or more of the following causes:  
*An improperly placed stoma.* A gastro-enteros-

tomy may function perfectly if made in any part of the stomach. Considering the many ways in which this operation is done it is truly remarkable, not that an occasional one fails to function, but that most of them function so well. We agree with Eusterman and Balfour that the position of choice for the stoma in a posterior gastro-enterostomy is in the most dependent portion of the stomach and nearly at right angles to the longitudinal diameter. When the operation is completed the distal jejunum should be in contact with the greater curvature and point toward the left hip. While the anastomosis is being made and the stomach is turned upward, this loop points toward the left shoulder (Fig. 1A). Because the operation is usually done through a midline incision and because the greater portion of the stomach lies well toward the left side, it is not uncommon for the surgeon to find that his anastomosis is located much nearer to the pylorus than he had anticipated.

*A stoma which is too small or which, because of its small size and narrow attachment to the stomach, produces an acute angulation of the jejunum.* The stoma may have been made too small originally or may have become so either because the stomach was dilated at the time of operation and later contracted, or because an unusual amount of tissue was inverted at the suture line during the anastomosis. With a wide stoma more gut is actually in contact with the wall of the stomach and the openings in the proximal and distal loops are further apart and more like a letter "U" than a letter "V" which makes it less likely that one loop will become distended and compress or obstruct the other.

The idea that "dumping" or too sudden emptying of the stomach may occur with a large stoma has been effectually exploded by the uniformly excellent function seen after subtotal gastrectomy in which the width of the entire end of the stomach is used. It is the small, not the large, stoma that gives trouble.

One other personal observation made upon experimental animals seems important, namely, that the stoma may be such a dense fibrous ring that it neither expands nor contracts to any extent.

From the Departments of Surgery and Anatomy, University of California Medical School.  
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extensive operative treatment. The results in the hysterectomy group are definitely superior to those in the myomectomy series. This study, therefore, indicates that when abdominal operation is indicated, hysterectomy is the better procedure for treatment of the fibromyomas. On the other hand, the mere presence of fibromyomas does not necessitate either hysterectomy or myomectomy.

#### CONCLUSIONS

In the treatment of the pregnant patient with uterine fibromyomas the following management is advised:

1. There should be careful observation during the course of pregnancy without interference unless symptoms of sufficient magnitude arise.

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3. Trial of labor should be permitted in doubtful cases.

4. When operative interference prior to delivery is indicated by necrosis in the tumor, by

obstruction to the birth canal, or by failure of normal uterine mechanism, it should consist of cesarean section with hysterectomy.

5. If operative interference becomes necessary during the puerperium, hysterectomy is also the procedure of choice.

6. Myomectomy with cesarean section carries an appreciably greater mortality and, therefore, its employment is generally contraindicated.

7. Fibromyomas *per se*, do not necessarily indicate either hysterectomy or myomectomy.

#### BIBLIOGRAPHY

1. CAMPBELL, R. F. *Am J Obst & Gynec* 1915 27 1
2. FISAMAN, J. R. *Am J Obst & Gynec* 1934 28 51
3. KOSMAK, C. W. *Am J Obst & Gynec* 1925 6 63
4. KASTNER, H. *Zentralbl f Gynaek* 1911 3 351
5. LANTLÉJOU, P. *Bull de Soc d obst et gynéc* 1915 24 275
6. MUSSY, P. D. and HARDWICK, R. S. *Am J Obst & Gynec* 1915 20 19
7. IERSON, R. N. *Am J Obst & Gynec* 1927 14 333
8. SPENCER, H. R. *Lancet* 1920 1 411
9. VALDESAL, R. *Brit M J* 1924 2 793
10. WATSON, B. P. *Am J Obst & Gynec* 1932 23 351

between the end of the stomach and the side of the jejunum so that distention of the stomach with food or gas tends to open up the stoma and attached jejunum as a part of its wall, and at the same time thrusts the whole anastomosis downward in the abdomen instead of compressing it. On the other hand, the extensive disturbance of normal relations, the opportunity for the soiling of and trauma to large areas of peritoneum, the possibilities of leakage either at the duodenal stump or along the suture line, make obstruction from adhesions possible.

Patients developing obstruction can be divided into 4 groups: (1) Those who develop gastric retention immediately after operation but who are eventually relieved by continued gastric lavage, showing that the obstruction was due to edema and swelling, (2) those who still have obstruction after from 7 to 14 days of conservative treatment, indicating that the obstruction is mechanical in character, (3) those who have been able to take food satisfactorily during the early part of their postoperative period and subsequently develop signs of obstruction. In such patients the obstruction is usually mechanical due to adhesions but occasionally may be adynamic in character, and (4) those who show weeks or years after operation either complete or incomplete obstruction caused by a marginal ulcer or its complications.

Patients in groups 2 and 3, having acute mechanical obstruction, obviously will require emergency surgery if their lives are to be saved. Of patients in these 2 groups, requiring secondary operation, it is not improbable, considering all cases, that 3 out of 4 fail to survive. The reason for such a high mortality is the fact that the surgeon does not know the exact cause of the obstruction before operation and frequently cannot determine it even when the abdomen is opened. He, therefore, has no plan of procedure to follow. Investigation by x-ray shows that the stomach fails to empty but no reason is obvious because the barium cannot pass further than the stoma. Too frequently the abdomen is opened and the stoma is exposed, after considerable dissection, palpated and found to be open and apparently satisfactory. The patient's condition will not allow an extensive operative procedure, so the surgeon, perplexed and uncertain in his own mind, does nothing more or reluctantly performs the usual entero-anastomosis below the stoma, or does an ileostomy, and hurriedly closes the abdomen. The patient may appear to be relieved but frequently continues a downward course and dies. At autopsy little evidence may be found to explain the cause of death. This failure to make a diagno-

sis is due to the fact that at no time was it possible to observe the bowel during peristaltic effort.

An entero-anastomosis would seem to be a logical procedure for relieving such an obstruction, but actually it has been disappointing both as an emergency measure and as a means of permanent relief. Ileostomy has been even less satisfactory, associated, as it frequently is, at this level with digestion of the abdominal wall and infection. As a rule, little is accomplished by either method because the obstruction actually exists at the point of the anastomosis which must be changed to restore normal function. Operations which heretofore have accomplished this have been too severe and time consuming for a patient already depleted by starvation and a recent operation.

#### A NEW JEJUNOPLASTY. I. FOR RELIEF OF ACUTE OBSTRUCTION

We propose a plan of procedure in these cases of acute obstruction—original in its purpose and application, as far as we know, but old in principle—which will relieve the obstruction at the point where it actually occurs with a minimum amount of surgery and at the same time will permit direct inspection of the gastric stoma.

As soon as the abdomen is opened and inspected for possible obstructive adhesions at a distance from the anastomosis, the anastomosis is identified and the jejunal loops are used for a jejuno-plasty to be made adjacent to the stoma and patterned after the principles of the Finney pyloroplasty. The loops of the jejunum are drawn downward from their attachment to the stomach, and their apposed serosal coats are sutured together for about 2 to 4 centimeters (Fig. 1 B). A central point for starting this line of suture may be chosen directly opposite the stoma or at either end, depending upon whether or not it seems advisable to shorten the proximal loop (Fig. 5). After the viscera are carefully packed off, an inverted "U" shaped incision is made around this suture line which opens both arms of the bowel (Fig. 1 C). When the edges are drawn apart, the stoma in the stomach can be directly inspected and palpated (Fig. 2 A). Having determined that the stoma is adequate, that no ulcer or faulty mechanics exist, the opening in the jejunum is closed by completing the technique used for a Finney pyloroplasty (2, 4) or some modification of it (5) (Figs. 2 A, 3). In this procedure the septum between the jejunal loops has been moved from 2 to 4 centimeters from the gastric stoma, and the original double barreled structure has been converted into a single barrel, the size now being that of the entire opening (Fig. 4). In fact,

with peristalsis for weeks or perhaps months after it is made.<sup>1</sup>

*A loop which is too long or too short for the changing position of the stomach* In the gastro-enterostomy of earlier times the proximal loop was made so long that, becoming filled and dilated it would empty itself intermittently into the stomach with the production of the corresponding periods of nausea and vomiting, the so called "vicious circle." Once this error was recognized and short loops were recommended they were frequently made too short with much the same result (1). The stomach has no fixed position. It is usually empty, contracted, and high in the epigastrium when seen on the operating table. When it is filled, however, it may sag of its own weight and lie in the pelvis although the mesocolon usually limits the mobility of the stomach after such operations. If the proximal loop is too short the stomach may drag upon or twist it and prevent its emptying.

*A mesocolon which fails to stretch when the stomach fills and its walls straighten out* This condition allows the anastomosis to be drawn up into or through the mesocolon. The importance of the transverse mesocolon in the success or failure of a gastro-enterostomy is still not appreciated by many surgeons. Ordinarily the mesocolon is thin and pliable and accommodates itself to the changing positions of the stomach. Frequently, however, it is naturally short, thick, and boardlike, or has become so from fatty deposits or from inflammation. If the wall of the stomach, with the anastomosis is drawn through an opening in such a mesocolon, what may be the result? Unless the opening is unusually large and the projecting stomach is sutured firmly around it, the anastomosis may be pulled up and become obstructed when the stomach fills and its wall attempts to straighten out. This can be demonstrated on the operating table by filling the stomach with water and then blowing it up with air or gas, or demonstrated in the laboratory by drawing the side of a rubber balloon through a hole in a board or rubber mat and then inflating it. This type of mesocolon is commented upon by Balfour (1) as being unsuitable for the operation of posterior gastro-enterostomy. If trouble is to be avoided here the opening in the mesocolon must be made unusually large and the stomach drawn well through it and firmly fixed in this position.

*Inadequate fixation by suture of the stomach to the mesocolon* If thorough fixation is not accomplished a part of the anastomosis or a distal loop

of the intestine may work its way through the opening into the lesser peritoneal cavity and become obstructed.

*Adhesions about the stoma due to leakage or trauma to the peritoneum* If the surrounding peritoneum has been soiled or traumatized adhesions may form which, as time goes on, become firmer and more obstructive in character. Adhesions of this type are commonly the cause of the obstructions which appear late in the period of convalescence.

*Pressure on the 2 loops of the jejunum by the middle colic artery* An obstruction of this type was recently reported by McCaughan and Coughlin who pointed out that, if the opening in the mesocolon is made to the right of the middle colic artery, this artery may produce obstructive pressure upon the jejunum.

*Marginal or jejunal ulcers at or near the stoma* The swelling and edema accompanying such ulcers and the contraction which follows may produce partial or complete obstruction. We have attempted to check the occurrence of acute ulcers in normal dogs on a normal diet. Observations were made in a small series from 7 to 28 days after gastro-enterostomy. We found ulcers in those cases only in which continuous non absorbable sutures had been used. These continuous sutures obviously caused the ulcers.

*Adhesions distal to the anastomosis* If the bowel becomes fixed in adhesions associated with the abdominal closure, or elsewhere, its contents may back up and induce hyperperistalsis which will give all the signs and symptoms of an obstruction at the stoma.

It should be noted that all of these causes of obstruction except the last one, namely, adhesions at a point distal to the anastomosis are operative in the area of the anastomosis itself.

With an anterior gastro-enterostomy the mesocolon is eliminated as an element of trouble, and to have the long loop of the jejunum required for this anastomosis substituted for it. An entero-anastomosis may prevent an obstruction but it also eliminates the alkaline duodenal content as a factor in the prevention of a marginal ulcer.

Obstruction following subtotal gastrectomy may arise from the same group of causes with the exception that, if the entire end of the stomach is used as a stoma the opening is usually so large that there is little tendency for acute angulation of the jejunum. Many surgeons, however, remove the lesser curvature entirely and reserve only a small opening adjacent to the greater curvature for the anastomosis. Even with this smaller opening, obstruction is less frequent than it is after gastro-enterostomy because the union is made

<sup>1</sup> Experimental observations will be published shortly on the factors which play a part in the rigidity of the stomal ring.

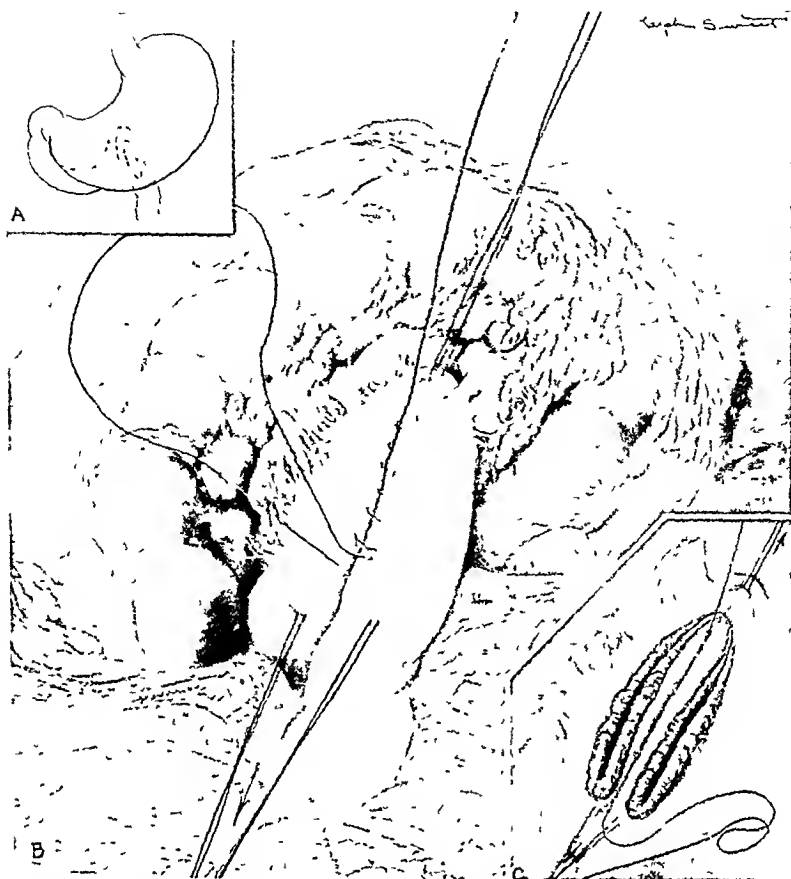


Fig 1 A, Stomach and posterior gastrojejunostomy B, Center point selected and the jejunum on either side of the anastomosis drawn parallel and united by running peritoneal sutures—the outer suture line C, Horseshoe shaped incision following the lumen of the gut and encircling the suture line

hesions could be followed only by their reformation and further obstruction. A jejunoplasty was performed without further loss of time. The two arms of the jejunum forming the anastomosis were drawn taut, the peritoneum was sutured together, and a "U" shaped incision was made opening the lumen of the gut. The stoma was found to be adequate and not ulcerated. The jejunum, however, was densely adherent in the mesocolon for a distance of at least 4 centimeters. Recovery was uneventful and the patient is now well except for the fact that he has an abdominal hernia.

CASE 4 (Illustrating Group 3) Mr W. K., 34 years of age, entered the hospital on December 18, 1934, complaining of the symptoms of duodenal ulcer of 18 years' duration for which a gastro-enterostomy had been done elsewhere 9 months before. The duodenal ulcer was cauterized at the same time. He was put on a medical regimen until November, 1935, when he again entered the hospital because of pain, weakness, fainting, and hematemesis.

A second operation, a Billroth II subtotal resection, was done on December 20, 1935. Inasmuch as his gastro-enterostomy was working satisfactorily and there was no marginal ulcer present, a subtotal resection of the stom-

ach, including the duodenal ulcer, but leaving the gastro-enterostomy, was performed. Two weeks later signs of obstruction appeared which eventually became complete, as no barium would pass the gastro-enterostomy stoma.

A third operation, a jejunoplasty, was done on January 25, 1936, 36 days after the second operation. Exploration showed that the stomach had rotated in such a manner that the loops of the jejunum were twisted and obstructed at the stoma apparently due to the loss of the gastrohepatic ligament after the gastrectomy. A jejunoplasty was immediately done, the patient made a satisfactory recovery and emptying of the stomach was again normal. He was relieved for a time but about a year and a half later began to show symptoms of a marginal ulcer.

The fourth operation, a radical subtotal gastrectomy (Mayo-Pólya), was done on October 14, 1937. A marginal ulcer was found on the posterior wall of the jejunum adjacent to the stoma. The patient made an uncomplicated recovery and is in excellent condition at this time with a total gastric acidity of only 13. It is still too early to know what may happen next. If he should develop another ulcer, inasmuch as there is no more stomach to resect, it may be visualized if necessary through another jejunoplasty.

a miniature secondary stomach has been created with its 3 openings more widely separated from each other. This cavity is similar in position and size to the pouch produced by the gradual dilatation and hypertrophy of the jejunum which is so frequently found in patients who have a gastro-enterostomy or a subtotal resection of long standing. The continuity of the jejunum has been restored so that its contents may pass directly downward, may bathe the gastric stoma, or may pass into the stomach. If any twist or compression of the jejunal loops existed it has an opportunity to straighten out. If the new suture line becomes covered by adhesions there is little likelihood of obstruction. In fact it is our practice to reinforce the anterior suture line with omentum.

This operative procedure does not require the time nor inflict the trauma incident to the breaking up of adhesions to expose the anastomosis from without. The adhesions are divided as the gut is split by the "U" shaped incision, which will naturally expose the stoma as it is carried to completion. The procedure can be completed with no more shock and with as much dispatch as an ordinary entero-anastomosis and has the obvious advantage of direct inspection of the stoma and the adjacent mucosa. It should be much more valuable and carry no greater operative risk than the usual entero-anastomosis.

CASE 1 (Illustrating the obstructions of Group 2.) Mr. H. W. S., 37 years of age, had a history of a duodenal ulcer for 5 years or more and had been on medical treatment for 2½ years. X-ray examinations showed the crater of an ulcer on posterior wall near pylorus with about 20 per cent retention of barium meal after 6 hours. Patient had had no bleeding but had had a good deal of pain and persistent vomiting. After rest in bed and gastric lavage daily for 1 week operation was performed on September 17, 1930.

The duodenum was found firmly fixed posteriorly by an ulcer which was attached to the pancreas. A short loop posterior gastro-enterostomy was done in the usual manner. The operation offered no difficulties. The mesocolon was not unusually thick or short. The patient showed no signs of leakage or peritonitis after the operation. He was unable to take any great amount of fluid or food from the beginning and continued to vomit except when his stomach was kept clear by the use of the Connell suction apparatus. At the end of 9 days barium did not pass and it was evident that the gastro-enterostomy had failed to function for some unknown reason.

Secondary operation for obstruction was performed on September 27, 1930, which was the tenth postoperative day. When the abdomen was opened there were few adhesions, the distal loop was free and the gastro-enterostomy opening was in excellent condition. The stoma seemed adequate from without and there was no kink or obstruction evident. Something radical had to be done but what? Every patient that I had seen with a similar condition including 2 of my own, had eventually died. Pondering this problem I noticed that the 2 arms of the jejunum forming the gastro-enterostomy lay side by side. The thought suddenly occurred why not a Finney pyloroplasty? If that

procedure would relieve obstruction at the junction why should it not achieve the same result here? It is to be the answer to a serious and as yet unsolved problem.

The two arms of the jejunal anastomosis were quickly sutured together and opened by means of an inverted L incision as here described. When the stoma was opened it proved to be surprisingly small, only about half the size of the original opening. This condition was probably the result of contraction of the somewhat dilated stomach and overlapping of the suture line. There was no sign of any perforation or ulcer. The second part of the operation which we have designated as a jejunoplasty was immediately completed.

The patient was able to take fluids the next day and made an uneventful recovery. He had excellent relief from the original symptoms. He was not heard of again for about 2 years when he was operated on elsewhere for a ruptured appendix and died of general peritonitis. At that time showed a well functioning gastro-enterostomy opening which could not be distinguished from that frequently seen long after the usual gastro-enterostomy. The duodenal ulcer had healed.

CASE 2 (Illustrating Group 2.) Mr. C. H. D., 33 years of age, entered the hospital on September 1, 1930, with a history of persistent vomiting and loss of weight. X-ray examination showed an almost complete pyloric block with a small niche on the lesser curvature which was diagnosed as a probable carcinoma. Exploratory laparotomy on September 27, 1930, showed the stomach to be extensively infiltrated with carcinoma which extended to the lesser curvature. No metastases were found. Because of condition and age of patient a gastro-enterostomy was done high up on the posterior wall. He continued to vomit and nothing passed through the gastro-enterostomy opening.

On October 10, 1930, the abdomen was opened and a jejunoplasty as herein described was done. The patient's stomach began to empty immediately and he made an excellent recovery. He was discharged on November 4, 1930.

CASE 3 (Illustrating the obstructions of Group 1.) Mr. J. F., 62 years of age, after medical treatment for a duodenal ulcer for a number of years had suffered repeated severe hemorrhages which could not be controlled by a well conducted medical regimen. At operation on November 4, 1934, the stomach was found to be large and atonic, the pyloric end was densely adherent posteriorly and could not be freed. About 6 centimeters beyond the pyloric end there was a large indurated mass with much surrounding inflammatory reaction. Because of the returning hemorrhage it was deemed advisable to exclude this ulcer by performing a subtotal resection of the Mayo-Polya type. The duodenum end was closed in the usual manner and a gastro-jejunal anastomosis was done by the postcolic route. The mesocolon was found to be short, thick and very heavily bled easily. It was thought that an adequate opening had been made in the mesocolon but it was fat and friable and a number of vessels bled, requiring ligatures. The entire opening of the stomach was anastomosed to the jejunum about 4 inches from the ligament of Treitz. The mesocolon was carefully sutured to the stomach. The operation was completed without difficulty as the convalescence was excellent.

He was taking food satisfactorily until the sixth day when he suddenly started to vomit. For the next 3 days he vomited everything given him. A small barium meal failed to pass through the stoma.

An emergency operation was performed on the thirteenth postoperative day. When the abdomen was opened numerous adhesions were found both in the duodenum and about the stoma. The adjacent jejunum was covered with adhesions which made it appear to be a part of the mesocolon. It seemed apparent that separation of the ul-

his patient from a situation which otherwise would have cost him his life

## II JEJUNOPLASTY AS AN APPROACH TO MARGINAL ULCERS, OR FOR ENLARGING OR CLOSING THE GASTRIC STOMA

Although this jejunoplasty was originally designed to relieve the acute obstructions occurring after gastrojejunal anastomoses, we were immediately impressed by the excellent exposure of the gastric stoma and the adjacent jejunum which it afforded. The occurrence of marginal ulcers with their sequels has been the most serious complication of gastric surgery. When ulcers occur and cannot be controlled by a proper medical regimen, the surgeon has the choice of 3 alternatives: (a) He may deal with the ulcer locally and continue to do so as necessary. (b) He may adopt a more radical procedure and do a subtotal gastrectomy. (This course is advocated by a majority of American and European surgeons.) (c) He may retrace his operative steps by closing the gastric stoma, provided the pylorus is open, and return his patient to the original status particularly if, in the meantime, the original lesion has healed. (This is the

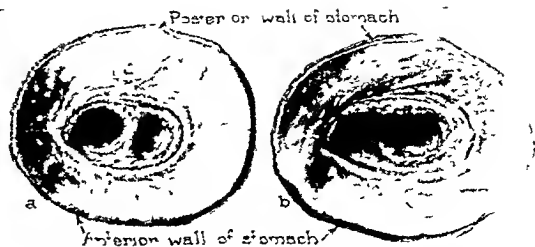


Fig 4 View of anastomosis from within the stomach a, Before the jejunoplasty b, After the jejunoplasty, showing how the septum has been split down restoring the continuity of the jejunal lumen and creating a potentially larger stoma

procedure of choice in England and Scotland where subtotal gastrectomies are seldom done except for cancer.)

If the surgeon is inclined toward conservatism or if more radical surgery is contra-indicated for any reason, we believe that this jejunoplasty, as an approach to the stoma, has many advantages over any other with which we are familiar.

**Gastrojejunal ulcer.** If an ulcer is present it can be dealt with by excision or cauterization without

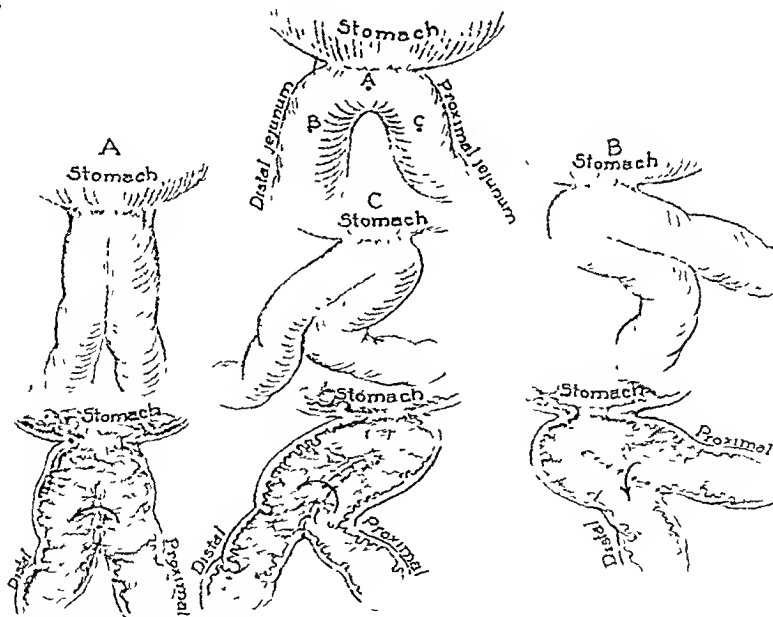


Fig 5 Sketch showing how the selection of a central point for starting the jejunoplasty will permit changing the length of the short loop and the resulting change in the lumen of the gut A, Central point using equal length of both proximal and distal jejunum, both shortened an equal amount B, Length of short loop not changed by reflecting the distal jejunum against it C, Maximum shortening of proximal loop by using it entirely for the jejunoplasty



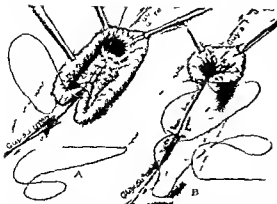


Fig. 2 A Outer edge of the incision retracted showing the stoma, inner catgut interlocking suture line completing the posterior wall B Inner catgut suture line carried to the anterior wall completing the closure by use of the Connell stitch

Someone will raise the question as to the viability of that strip of jejunum which lies between the inverted U shaped incision and the gastro jejunal anastomosis. The question of the circulation of this strip was uppermost in our minds and formed the basis of a large number of operations upon experimental animals. Occasionally there was some cyanosis in this strip but we found no necrosis or leakage. As the strip is cut off from its original blood supply, however, we recommend

that the anterior suture line be routinely reinforced with the omentum as a precautionary measure. The posterior suture line is still in contact with its mesenteric vessels and obviously has a good circulation. By reinforcing the anterior suture line there is little danger of further obstruction such as might occur after reinforcing a gastroenterostomy anastomosis, because the lumen of the gut then lies in the plane parallel to the line of sutures.

Will this jejunoplasty influence the hazard of marginal ulcer? We think it unlikely, because the procedure simply increases the lumen of the jejunum and makes the anastomosis what it should have been originally.

The relief afforded to this group of patients with acute obstruction is most striking. Fetched and depleted by the loss of 2000 cubic centimeters or more of duodenal secretions daily and kept alive only by intravenous medication before operation, they may be found reading the paper or smoking a cigar (as happened in one of our cases) on the day after. This sudden change for the better emphasizes again the importance of the duodenal secretions. We can recommend this procedure without reservation for these acutely obstructed patients who heretofore have proved so troublesome and in whom the mortality has been so high. It has been called the 'fire escape' of the gastric surgeon, a way out, by which he is able to rescue

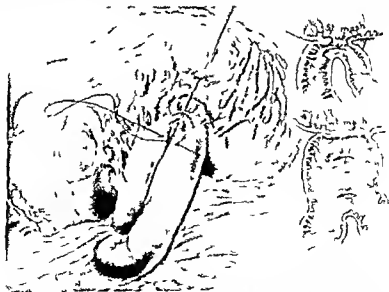


Fig. 3 A Completion of outer peritoneal suture line by continuing it from the posterior wall B Sagittal section of stomach, stoma and jejunum before jejunoplasty C, After jejunoplasty

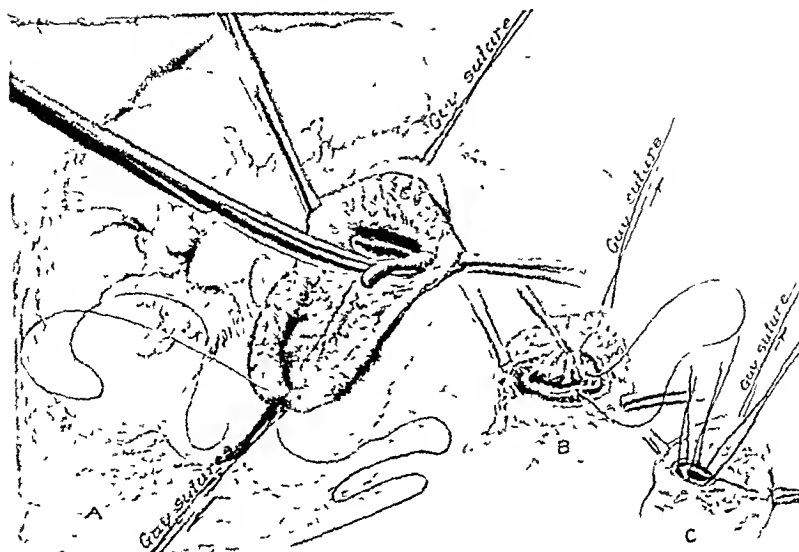


Fig 10 Complete closure of the gastric stoma from within the gut (Approach and closure as in Figs 1, 2, and 3) A, Mucous membrane covering the rim of the stoma excised exposing a wall made up of (1) muscularis mucosa of the stomach, (2) combined muscle of the stomach and jejunum, and (3) mucous membrane of the jejunum B, Muscularis mucosa detached from around the stoma and everted into the stomach by the Connell stitch of catgut C, Muscular layer closed with interrupted silk in the direction in which the stoma was originally made These stitches approximate but do not penetrate the firmly attached jejunal mucosa which falls together as the muscle is approximated, and usually does not require a separate suture

ulcer, it can be enlarged with the greatest of ease as a final step in completing the jejunoplasty. In addition the surgeon does not have to make this decision until the lesion has been removed and he has had an opportunity to appraise the size of the repaired opening. If he wishes to enlarge it a vertical incision is made from the superior margin of the original inverted "U" incision across the stoma into the stomach as far as is necessary for the size desired (Fig. 7). A new center is then chosen for closing the entire incision so that the divided ring can be separated by interposing gastric or duodenal tissues between its ends (Figs 8, 9), taking more tissue in each stitch on the longer side.

**CASE 5** Mr A A, 37 years of age, first entered the hospital in 1924 and a posterior gastro-enterostomy was performed because of a densely adherent duodenal ulcer. He had some relief but returned 6 months later with a marginal ulcer. He was treated conservatively and improved.

A second operation was done in 1929. The old gastro-enterostomy stoma was partly obstructed by a marginal ulcer and there was evidence that the duodenal ulcer still persisted, so a subtotal resection (Mayo-Pólya) was done. In November, 1931, the patient returned with a second marginal ulcer and was treated medically with varying degrees of relief. In January, 1938, he returned with severe pain, having a 90 per cent retention, not only in that part

of the stomach which still remained but also in the closed duodenal stump.

In February, 1938, gastrojejunoplasty was performed. Laparotomy showed dense adhesions about the stoma, colon, and jejunal loops. These loops were distended both distad and proximad to the anastomosis. The stoma was exposed by doing the first portion of the jejunoplasty. The opening was found to be very small and contracted and there was a very small marginal ulcer on the posterior rim. This ulcer was destroyed by the cautery. The stoma was enlarged by carrying the incision from the inverted "U" incision in the jejunum across the stoma into the stomach for about 4 centimeters. This combined line of the jejunum and stomach was then closed by staggering the edge of the incision and interposing gastric tissue between the divided ends of the stomal ring, or a "gastrojejunoplasty." Convalescence was uneventful and there is no retention. It is, of course, too early to determine the final result.

**Closure of the stoma** In certain cases in which the gastro-enterostomy is unsatisfactory because of recurring marginal ulcers and in which the pylorus is open, it may be desirable to restore the original continuity of the bowel rather than to attempt to deal with the lesions locally, or subject the patient to a subtotal gastrectomy. In such an event, this approach permits complete closure of the stoma from inside, without the necessity of detaching the jejunum from the stomach or of resecting the jejunum and doing an anastomosis.



Fig 6 First part of the jejunoplasty complete as an approach for the removal of a marginal ulcer

disturbing the anastomosis and what is more important without the usual danger of narrowing the stoma. The additional room gained by virtue of the jejunoplasty more than offsets any narrowing that may occur by removing the ulcer (Fig 6)

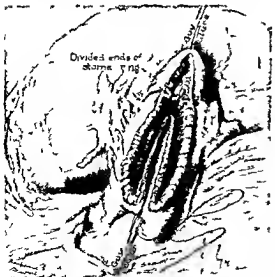


Fig 8 Gastrojejunoplasty to enlarge the stoma. Incision is carried across the stoma into the stomach

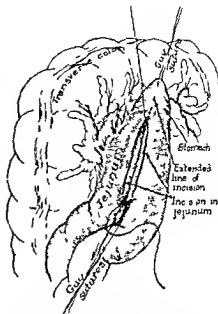


Fig 7 Enlargement of the stoma. Line of incision from U incision across stoma into stomach

*Enlargement of the stoma* If the stoma is found to have been made too small originally or to have become contracted from the presence of a marginal ulcer or narrowed through the excision of an

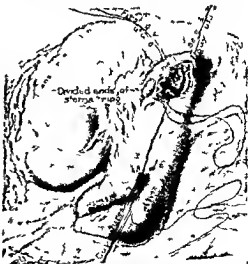


Fig 9 Closure of the anterior wall of the jejunum and stomach by staggering the suture line and interposing gastric wall between the ends of the divided stoma to increase its size. (Wider stitches on long side)

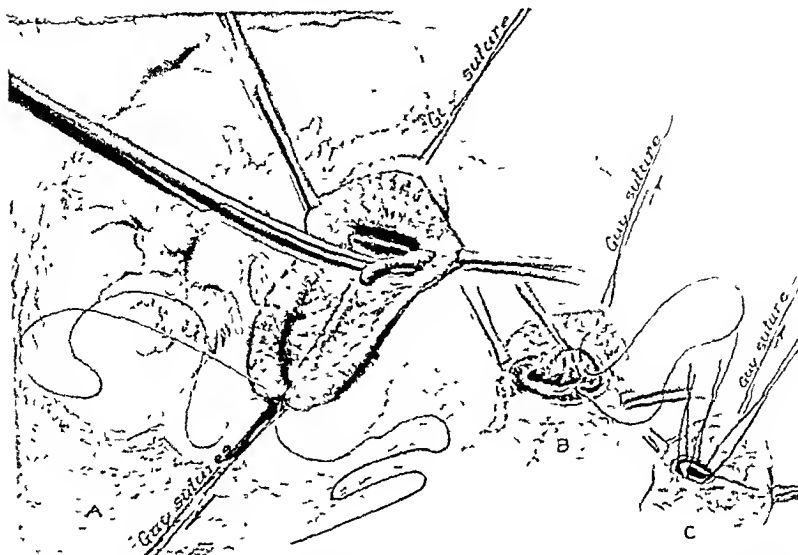


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The stoma is pushed forward by the hand of the assistant which may be placed behind the stomach or even in the lesser peritoneal cavity if necessary. After the first part of the jejunoplasty has been completed, the mucous membrane around the rim of the stoma is excised with curved scissors. The free edge of the muscularis mucosa is detached around the entire circumference of the opening and everted into the stomach with a Connell stitch. This is best done by using fine gastro-enterostomy catgut and everting it by a double row of sutures. Following this the muscle layer of the ring is closed with interrupted silk in the direction in which it was originally made. This stitch includes the entire muscle layer and approaches but does not penetrate the jejunal mucous membrane. It may approximate the jejunal mucosa so well that a third line of sutures (catgut) may not be required for this layer (Fig. 10). The second portion of the jejunoplasty is then completed in the usual manner. We wish to emphasize the importance of having the assistant push the anastomosis well up into the field so that it is readily accessible and will permit this closure with a minimum of traction and trauma. While the closure of the stoma offers no unusual technical difficulties, it is suggested that those interested in mastering the details of this technique may find it advantageous to try it out on the cadaver or experimental animal.

It should also be pointed out that whenever the stoma is to be closed a longer anastomosis of the jejunal loops is necessary to prevent the swollen tissues about the closed stoma from encroaching upon the lumen of the jejunoplasty. In all other conditions except this one in which the stoma is closed and the neutralization of acid ceases to be a factor, the anastomosis should be made as short as is consistent with the correction of the mechanical difficulties (usually 2 to 4 centimeters) so that the alkaline duodenal secretions will continue to bathe the stoma and minimize the hazard of a marginal ulcer.

In virtue of our limited experience with these procedures we do not at this time desire to leave the impression that we are advocating them as a substitute for subtotal gastric resection in the treatment of marginal ulcer, except when the more radical operation is contra-indicated or when a marginal ulcer has occurred after subtotal resection.

#### CONCLUSIONS

1. Obstruction following gastro-enterostomy or subtotal resection of the stomach may be caused

by (1) an improperly placed stoma (2) one that is too small in itself or because of its narrow attachment angulates the jejunum (3) a jejunal loop which is either too long or too short for the changing positions of the stomach (4) a mesocolon which fails to stretch when the stomach wall straightens out and causes the anastomosis to be drawn into or through it (5) herniation resulting from an inadequate fixation of the mesocolon to the stomach (6) pressure of the middle colic artery on the jejunal loops (7) adhesions about the stoma (8) marginal ulcers or their sequelae and (9) adhesions about the gut distal to the stoma.

\* A new jejunoplasty adjacent to the stoma has the distinct advantage of (1) relief of the obstruction at the anastomosis where it actually occurs (2) direct inspection of the stoma from within, (3) formation of a miniature stomach in which duodenal secretions continue to bathe the stoma, (4) re-establishment of the direct continuity of the jejunum (5) a potentially larger stoma and (6) a minimum amount of surgery.

In the acute obstructions we are convinced that the mortality rate can be easily reversed. Whereas an estimated 75 per cent of patients requiring re-operation previously have died it is possible with this procedure to save 75 per cent or even a greater number.

3. This jejunoplasty may be used in chronic obstructions as an approach for (1) the resection of marginal ulcers (2) increasing the size of the stoma—a gastro-jejunoplasty, and (3) permanent closure of the stoma and restoration of the original continuity of the gut.

The authors wish to thank Dr. Henry Seale, Dr. H. Glenn Bell, Dr. Leon Goldman, Dr. Harold Lindner, and Dr. Harry Benteen for their generous assistance in carrying out the clinical and experimental investigations associated with this problem.

#### REFERENCES

1. FUSTERMAN, C. and BALFOUR, D. C. *The Stomach and Duodenum*. Pp. 305, 308, 310. Philadelphia and London: W. B. Saunders Co. 1931.
2. FINNEY, J. M. T. *Original article*. *J. Am. Surg.* 1902, 20: 265.
3. FINNEY, J. M. T. and HANRAHAN, F. C. *Am. J. Surg.* 1930, 42: 620.
4. FINNEY, J. M. T. Jr. *Surg. Gynec. & Obst.* 1936, 41: 503.
5. *Idem*. *Surgery* 1937, 2: 748.
6. GRAHAM, R. R. *Surg. Gynec. & Obst.* 1937, 66: 42.
7. MARSHALL, S. F. and KIRBY, F. D. *J. Am. Med. Ass.* 1937, 109: 1347.
8. McCALGAN, J. M. and CORDELLAN, W. T. *Surg. Gynec. & Obst.* 1937, 65: 824.

# FRACTURES OF NECK OF THE FEMUR TREATED WITH SMITH-PETERSEN NAIL

## Analysis of 78 Cases During 1937

STANLEY M LEYDIG, M D, Saint Louis, Missouri

FROM January 1, 1937, to January 1, 1938, 166 fractures of the hip were admitted to St. Louis City Hospital, 88 were trochanteric fractures, and 78 were fractured necks of the femur. Further classification seems unnecessary as in our experience of previous years there has not been any difficulty in securing bony union of extracapsular fractures, while the contrary has been true of displaced intracapsular fractures. No differentiation is made between subcapital or central intracapsular fractures, as the difficulty in treatment and prognosis of these types has been similar. Fractures at the base of the neck in which the neck is split off from the shaft are not included in this report and were classed with the trochanteric fractures. Impacted fractures of the neck of the femur, which in our experience have usually united, are classified separately. The average age of patients with fracture of the neck of the femur was 66 years and the average age of those who expired was 68.

Of the 78 cases, 14 were impacted fractures of the neck of the femur. These fractures united in all cases, and such has been our result in previous years, regardless of the type of treatment. Seven of the impacted fractures were treated in the body spica casts, 4 were nailed with the Smith-Petersen nail, 1 was treated in a Hodgen splint, and 2 were treated with bed rest only. All are now walking and apparently have bony union, with the exception of 2 cases that were nailed. These also will probably unite but have not been under observation a sufficient time.

Of the 64 cases with displaced intracapsular fractures of the femur, 10 were moribund on admission and remained so until their death. In these cases, the fracture was treated only by traction and immobilization in sand bags. Six cases were treated in body spica casts, 3 united and 3 went on to non-union, with complete absorption of the neck of the femur. The remaining 48 cases were reduced and nailed with the Smith-Petersen nail (7). Of the 52 patients with fractures that were nailed, including 4 cases of impacted fracture, there were 13 patients who expired during the course of the year. Of this number, 3 gradu-

ally terminated in uremia, 1 died of pneumonia several weeks after operation, 2, of cardiac decompensation, 1, with pulmonary embolism, 1, apparently of too much morphine before operation ( $\frac{1}{2}$  grain of morphine), 1, of carcinoma of breast (pathological fracture), 1 of delirium tremens, 2, of wound infection with septicemia, and 1, of femoral thrombosis with ensuing gangrene. I believe that in only 8 of this group was there any expectancy of sustaining life for long. The 5 remaining probably would have expired within the year had the fracture of the hip not occurred. The fractures were nailed only to facilitate nursing care and add to the patients' comfort, as these cases lived from 3 to 7 weeks after operation.

If these 5 cases were not considered, there would be 8 deaths out of 47 cases, and the mortality would be 17.2 per cent. Two patients expired because of wound infection which was a direct result of the operation.

These results represent the work of 2 surgeons, Dr. Norman Johnson, who handled 15 cases, and the author, who took care of 37 cases, with the exception of 3 or 4 cases done by the visiting surgeons, Dr. J. Albert Key, Dr. Peter J. Heinbecker, and Dr. Avery P. Rowlette, to whom we are indebted and grateful for their interest.

The percentage of union is difficult to determine at this time, as 6 months should elapse before one can say that bony union will not result, and in some cases several years must elapse, as 2 cases which were reported as non-union by Dr. Avery P. Rowlette, et al., in 1936, have since united, after being under observation for 2 years. Of 39 living patients, including 4 impacted cases, 23 are able to walk without support. Six cases are unable to walk even with crutches, 3 of these cannot walk because of their senescent condition, but the other 3 could not walk before the fracture occurred, due to atrophic arthritis, chorea, and hemiplegia, 4 would not return for re-examination and 6 are too recent to determine prognosis.

Of the 23 patients walking, 10 show absorption of the neck of the femur, which is nearly complete in 2 instances, although bony union appears to be present (Fig. 6). Of the 3 patients who could not

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#### REFERENCES

1. PASTERNAK C. and BALFOUR D. C. The Stomach and Duodenum. Pp. 305-308-310. Philadelphia and London W. B. Saunders Co. 1935.
2. FINNEY J. M. T. Original article. *Tr. Am. Surg. A.* 1902, 20, 165.
3. FINNEY J. M. T. and HANNAHAN F. C. *Am. J. Surg.* 1930, 92, 620.
4. FINNEY J. M. T. Jr. *Surg. Gynec. & Obst.* 1934, 58, 503.
5. *Idem* *Surgery* 1937, 2, 748.
6. GRAHAM R. R. *Surg. Gynec. & Obst.* 1938, 66, 749.
7. MARSHALL S. F. and KIEFER F. D. *J. Am. M. Ass.* 1937, 109, 1341.
8. McCauley J. M. and COUGHLIN W. T. *Surg. Gynec. & Obst.* 1937, 65, 824.



Fig 5 Our own devised nail driver and impactor. The flange rests against the shaft and is prevented from slipping by the 4 sharp pins that protrude. The flange is at an angle of 125 degrees to the cylinder which corresponds to the angle which the neck of the femur makes with the shaft. The nail is placed in the cylinder and the plunger is inserted. The set screw is then turned tightly against the plunger. Thus the force of each blow is divided against the nail and against the impactor, so that the fragments are impacted as the nail is driven.

ing This procedure is done in our fluoroscopic room and necessitates taking only 4 x-ray plates, an anteroposterior and lateral view after reduction, and again after the nail has been started.

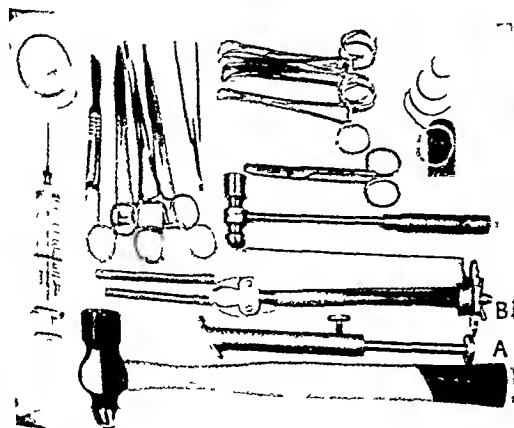


Fig 7 Tray with all instruments used. A, Impactor and nail driver. B, Nail extractor.



Fig 6 Illustration of aseptic necrosis around the nail, and absorption of the neck with bony union. Patient has only a slight limp, walks without support, and has no pain.

It rarely takes over 45 minutes for both the reduction and completion of operation.

We have done several cases by direct visualization with an incision from the anterosuperior spine down to below the trochanter, cutting the tendon of the tensor fascia lata, and opening the capsule. This method impresses us as being a rather extensive surgical procedure and only applicable to the more vigorous cases.<sup>1</sup>

In one such operation it was noticed that while driving the nail the head displaced slightly inward, and impaction of the reduced fragments was difficult to maintain. After the nail had been driven

<sup>1</sup>Since the preparation of this paper an interesting article on the same procedure has appeared in *SURGERY, GYNECOLOGY AND OBSTETRICS* for January, 1939, by W. R. Cubbins, J. J. Callahan, and Carlo S. Scuderi.



Fig 8 The nail was inserted about  $\frac{1}{8}$  inch too far and after observation for a year some necrosis of the acetabulum was seen at the point of the nail. The patient can walk without support and has had no pain.





Fig 1 Section through femur with nail in place. Patient expired 2 weeks after operation of dehrium tremens

walk before they fractured their hip. 2 showed complete absorption of the neck of the femur, with non union of the 3 that never walked without crutches after their fracture. 2 showed complete absorption with non union, and the third has united. Thus of 27 known living patients 14 or 51 per cent showed some degree of absorption of the neck of the femur.

Of 35 living patients that had displaced intra capsular fractures that were reduced and nailed the reduction was considered good in 27 cases, and only 5 of these showed absorption of the neck of the femur not over three fourths of an inch, and in these cases the nail was accurately placed (Figs 1, 2). There were 8 cases in which the reduction was imperfect, absorption was complete in 6 of these patients and marked in the 2 others (Figs 3 and 4). Whenever absorption of the neck was observed it had occurred within 4 months of the operation. There were no cases in which absorption occurred if the reduction and the nailing were accurate, provided the patient was not bedridden and was able to use crutches. The average number of hospital days per patient was 22 days.



Fig 3 Only fair reduction and nailing of fracture



Fig 2 Good reduction of fracture and accurate nailing

The method used in nailing was the same as that described by Dr J. Albert Key, the so called blind method in which reduction was done under local anesthesia by the Leadbetter maneuver and the Smith Petersen nail inserted through a 6 inch incision over the trochanter after inserting a drill and checking the position by portable x ray in the operating room.

During the past few months we have modified the technique, and now drive the nail with our own devised impactor through an incision 1½ inches long, without previously inserting a guide such as the drill. The smaller incision decreases the chances of wound infection, shortens the time of the operation, and lessens the amount of blood



Fig 4 Imperfect reduction with complete absorption of the neck after 10 months although bony union is present

Of the patients who survived 51 per cent showed some degree of absorption of the neck, and whether early weight bearing is a factor in absorption and is to be advised will have to be decided in the future

Accurate reduction, and accurate nailing with early weight bearing on crutches has been our desire. It is interesting to note that when these 3 conditions have been fulfilled, the fracture has healed with apparent bony union and good function

#### BIBLIOGRAPHY

- 1 CAMPBELL, WILLIS C Fractures of neck of femur  
Ann Surg, 1937, 105 939
- 2 HENDERSON, M S Internal fixation of fractures of  
the neck of the femur Arch Surg, 1937, 35 419
- 3 KEY, J ALBERT Insertion of Smith-Petersen nail for  
intracapsular fractures of the neck of femur Am J  
Surg, 1937, 36 466-467
- 4 LEADBETTER, G W A treatment for fracture of neck  
of femur J Bone & Joint Surg, 1933, 15 931
- 5 MOORE, AUSTIN Fracture of the hip joint, treatment  
by extra-articular fixation with adjustable nails  
Surg, Gynec & Obst, 1937, 64 420-437
- 6 ROWLETTE, AVERY P, HASLEW, J R, SIEGERT, R B,  
MORRIS, H D, and KEY, J ALBERT Results ob-  
tained by subcutaneous pinning of fractures of the  
neck of femur J Am M Ass, 1936, 107 1610-1614
- 7 SMITH-PETERSEN, M N, CAVE, E F, and VAN  
GORDER, G W Intracapsular fractures of the neck  
of the femur, treatment by internal fixation Arch  
Surg, 1931, 23 715
- 8 VENABLE, CHARLES S, STUCK, WALTER G, and BEACH,  
ASA The effects on bone of the presence of metals,  
based upon electrolysis An experimental study.  
Ann Surg, 1937, 105 917

TABLE I—FRACTURED NECKS OF THE FEMUR FROM 1931 TO 1936 AND THOSE IN 1937

	1931-1936	1937
No of fractures	166	64*
Average age in years	63.8	66.0
Mortality per cent	25.9	28.2
Average age of deaths	71.2	68.0
Average no. of hospital days	83.0	22.4

\*This number does not include 14 impact fractures.

in as far as necessary there was a slight separation of the fragments which was not improved by further impaction although rays taken after operation showed good approximation. This has undoubtedly occurred before with the blind nailing method, and it was this observation that led us to devise our own type of nail driver which impacts the fragments as the nail is being driven (Fig. 5). We make an attempt to get the patients up on crutches as soon as possible after operation and encourage them to place their affected extremity on the floor, bearing a slight amount of weight. After 3 months they have usually discarded 1 crutch and after 5 months they are walking with a cane, which most of them prefer using for several months longer. We remove the nail after 1 year and find that it is easily extracted.

The following chart is a comparison of fractured necks of the femur at City Hospital from 1931 to 1936 and 1937.

Among many objections now heard concerning the use of the Smith Petersen nail is the presence of metal being a cause of local bone absorption (b) and delayed union (1). Aseptic necrosis around the nail was seen in only 3 of our patients and was without ill effect (Fig. 6). The amount of metal in the Smith Petersen 3 flanged stainless steel nail is no more than if multiple Kirschner wires or several pins (5) were used, and the type of nail which we use is no more expensive. We do not feel that an array of various sized nails is necessary and have only 2 nails on our sterile tray (Fig. 7) a  $3\frac{1}{2}$  inch and a 4 inch nail and by varying the point of insertion below the trochanter, we have had very little difficulty in inserting the nail at the correct distance. In 1 case the nail was inserted too far and after observation for a year there was some slight absorption of the acetabulum at the point of the nail (Fig. 8) but the patient has always walked without pain and uses no support.

Various devices have been used in an attempt to answer the problem of the nail backing out due to absorption of the bone around it (2). Some have resorted to fixing the head of the nail to the cortex of the shaft of the femur with a pin. If

TABLE II—COMPARISON OF TWO METHODS OF TREATMENT USED FOR FRACTURED NECKS OF FEMUR

Method	1935-1936 (27)	1937 Smith Petersen (31 cases)
No of cases	30	4*
No of months observed	8	4
Mortality—no and per cent	6-20	13-27
Traced or re-examined	20	18
Non union	7	4
Bony union—no and per cent	13-40	19-13†

\*This number does not include 4 impact cases.

†If 6 deaths be subtracted the average would be 18 per cent.

‡If 15 deaths be subtracted the average would be 29 per cent.

even slight absorption of the neck should occur the nail would then tend to hold the fragments apart, making non union inevitable unless the nail worked through the head into the acetabulum with obvious possible complications. In only 3 of our cases has the nail worked out and in each instance was easily reinserted. Two of these cases have healed with bony union and the other is too recent to determine the prognosis.

#### CONCLUSION

Although a longer period of observation would be desirable, one can determine the prognosis in fractures of the neck of the femur treated by the Smith Petersen nail much earlier than formerly as a long period of observation was necessary in cases treated with the Whitman cast, or subcutaneous pinning. Furthermore, our report is offered at this time because of the present widespread interest in internal fixation of fractures of the neck of the femur and also because of the difficulty in following up our patients over a longer period as a large number of them have no permanent residence throughout the year.

These statistics show that much is yet to be desired in results with the Smith Petersen nail but it must be remembered that these cases come from an underprivileged group and their poor general condition has contributed to an undesirable result in many cases.

Before 1935 internal fixation of intracapsular fractures had not been attempted in this hospital and patients were treated in a Whitman spica cast with very few cases of union resulting. Internal fixation with the 2 pin method used in 1935 to 1936 showed a marked improvement and resulted in 58 per cent union in patients who survived (6). The Smith Petersen nail has increased bony union to 89.4 per cent in patients who survived and has cut the average number of hospital days per case to almost a fourth of what it had been previously.

ment of that period. This would be true unless the student had learned how to learn either in school or subsequently. Why not in the medical school? In the program of graduate training in surgery at the University of Chicago, the candidate after completion of the interne year is required to spend a year in research, either alone or in association with a member of the staff. It is not our thought that any considerable proportion of these men will become professional investigators or occupy academic positions, but rather that they will benefit from the experience as part of the educational process. The beginner makes many mistakes, and he draws conclusions not warranted by the evidence, but he learns by the experience, he becomes aware of many pitfalls, and he is better able to evaluate what he reads. It is unfortunate that all students cannot be given this advantage. The program is expensive. It consumes much of the teacher's time and energy and there is considerable waste of material. Possibly not all students are sufficiently capable to warrant the expenditure of effort and money. But where it can be done, let it not be discouraged. Medicine is not static and the method of its progress should not be kept secret.

LESTER R. DRAGSTEDT

## INTRAVENOUS ANESTHESIA

THE increasing usefulness of intravenous anesthesia for many types of operations has never been as apparent as it has recently. The criticism of the method in the past was often well deserved, as most of the agents employed were essentially unsuitable and in some instances dangerous. The longer-acting barbiturates, so many of which enjoyed a brief but extensive use, were soon seen to have many disadvantages as anesthetic agents. The evolution of

the so called ultra-short-acting barbiturates opened up the field of intravenous anesthesia as we know it today and has provided us with a method which has proved safe, satisfactory, and essentially free from complications, when the agents are administered by experienced persons for suitable types of operations. In other words, intravenous anesthesia now has a definite place among the various anesthetic methods. The barbiturates that have proved most satisfactory in this field are evipal soluble (sodium n-methyl-cyclohexenyl methyl barbituric acid) and pentothal sodium (sodium ethyl-1-methyl butyl barbituric acid). While the action of these drugs is similar, most authorities feel that pentothal sodium, owing to its increased potency over evipal soluble, provides a superior anesthesia and that the awakening of the patient is usually attended by somewhat less excitation and other post-anesthetic effect than when evipal soluble is employed. Preliminary medication with morphine, atropine, and a barbiturate is of advantage in all but the most brief operative procedures. The intermittent or fractional method of injection has proved to be the safest method of administering these drugs, and no set dose should be computed. Individual tolerance of the patient for a barbiturate is a most variable factor. A free airway should be maintained at all times, either by support of the patient's jaw when required, or by the introduction of an artificial airway. Perhaps the most important single factor to be observed when administering barbiturates intravenously is never to administer a dose which causes prolonged respiratory depression. The amounts of the drug necessary to induce anesthesia and those subsequently required to maintain it serve as a reliable guide to the patient's tolerance. As an aid to the observation of the respiratory functions, the movements of a cotton or paper "butterfly" which

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## ON MEDICAL EDUCATION

IN a recent charming book<sup>1</sup>, Dr Arthur I Hertzler makes the following statement about medical teaching and teachers: 'I give place to no man in the appreciation of the medical researcher, but his problems are not for the medical student. Researchers should be quarantined both for their own good and for the good of the student. I speak sympathetically because I have dabbled in the border lines myself, but I have never mentioned them to my students. The fact should be recognized that the average doctor never does catch up with what the researcher is doing. We doctors should be spared the agony of the scientific delivery room and should be allowed to hold the baby only after the nurse has him all polished up and dressed.' This is, as I understand it, a picturesque statement of the position held by many that the student learns best by the didactic method and should be spared the agony of thinking

for himself. It assumes furthermore that the scientific babies finally do become dressed and polished and that the clothes will not later (after graduation) need to be changed.

Mr Dooley was a bartender on Archer Avenue in Chicago during the early years of the century and was wont to discuss many things with his friend, Mr Hennessy, which were recorded for a larger audience by Finley Peter Dunne. On the subject of education, Mr Dooley had this to say: "Childder shud den't be sent to school to larn, but to larn how to larn. I don't care what ye larn them so long as 'tis onpleasant to them. 'Tis thraimin' they need, Hinissy." I prefer the philosophy of the sage of Archer Avenue to that of the famous "horse and buggy doctor" of Halsted Kansas. I believe that only the man who knows by experience the method of original investigation, its difficulties and disappointments, and the tentative character of its conclusions, is qualified to teach science, at least at the graduate level. Only the investigator can really appreciate the basis in fact for the opinion that passes as knowledge. Once this opinion becomes sanctified by inclusion in a textbook and clarified and elaborated in subsequent textbooks based on the first, it forms part and parcel of common knowledge and its position becomes almost unassailable.

I have sometimes had occasion to glance at notes prepared for lectures to medical classes twenty years ago and to reflect on the status of our knowledge at that time and today. I am appalled at the thought that some may be working now with the equip-

<sup>1</sup> Arthur I. Hertzler, *The Horse and Buggy Doctor*, Harper Brothers, 1935.

<sup>2</sup> F. P. Dunne, *Mr Dooley's Philosophy*, Harper Brothers, 1906.

ment of that period. This would be true unless the student had learned how to learn either in school or subsequently. Why not in the medical school? In the program of graduate training in surgery at the University of Chicago, the candidate after completion of the interne year is required to spend a year in research, either alone or in association with a member of the staff. It is not our thought that any considerable proportion of these men will become professional investigators or occupy academic positions, but rather that they will benefit from the experience as part of the educational process. The beginner makes many mistakes, and he draws conclusions not warranted by the evidence, but he learns by the experience, he becomes aware of many pitfalls, and he is better able to evaluate what he reads. It is unfortunate that all students cannot be given this advantage. The program is expensive. It consumes much of the teacher's time and energy and there is considerable waste of material. Possibly not all students are sufficiently capable to warrant the expenditure of effort and money. But where it can be done, let it not be discouraged. Medicine is not static and the method of its progress should not be kept secret.

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## INTRAVENOUS ANESTHESIA

THE increasing usefulness of intravenous anesthesia for many types of operations has never been as apparent as it has recently. The criticism of the method in the past was often well deserved, as most of the agents employed were essentially unsuitable and in some instances dangerous. The longer-acting barbiturates, so many of which enjoyed a brief but extensive use, were soon seen to have many disadvantages as anesthetic agents. The evolution of

the so called ultra-short-acting barbiturates opened up the field of intravenous anesthesia as we know it today and has provided us with a method which has proved safe, satisfactory, and essentially free from complications, when the agents are administered by experienced persons for suitable types of operations. In other words, intravenous anesthesia now has a definite place among the various anesthetic methods. The barbiturates that have proved most satisfactory in this field are evipal soluble (sodium n-methyl-cyclohexenyl methyl barbituric acid) and pentothal sodium (sodium ethyl-l-methyl butyl barbituric acid). While the action of these drugs is similar, most authorities feel that pentothal sodium, owing to its increased potency over evipal soluble, provides a superior anesthesia and that the awakening of the patient is usually attended by somewhat less excitation and other post-anesthetic effect than when evipal soluble is employed. Preliminary medication with morphine, atropine, and a barbiturate is of advantage in all but the most brief operative procedures. The intermittent or fractional method of injection has proved to be the safest method of administering these drugs, and no set dose should be computed. Individual tolerance of the patient for a barbiturate is a most variable factor. A free airway should be maintained at all times, either by support of the patient's jaw when required, or by the introduction of an artificial airway. Perhaps the most important single factor to be observed when administering barbiturates intravenously is never to administer a dose which causes prolonged respiratory depression. The amounts of the drug necessary to induce anesthesia and those subsequently required to maintain it serve as a reliable guide to the patient's tolerance. As an aid to the observance of the respiratory functions, the movements of a cotton or paper "butterfly" which

is fastened by adhesive tape over the patient's mouth and nose, will add to the safety of the method.

Some of the literature on the usefulness of intravenous anesthesia may be confusing to many readers, as it is so often contradictory. The wave of enthusiasm for many new methods has been very well demonstrated by writers in this field. The more ardent enthusiasts recommend the method as being practically ideal for almost every type of operation while some go to the other extreme and condemn it whole heartedly. Neither of these conceptions gives the reader a true picture of the present status of intravenous anesthesia. Many justifiable criticisms in the past have arisen from the use of unsuitable drugs or faulty methods of administration, and from choosing the method for patients or operative procedures in which its use should have been contraindicated. Generally speaking, the method is most applicable for short and minor surgical procedures ranging from fifteen to thirty minutes especially in cases in which the operative procedure does not involve the respiratory passages or the peritoneal cavity. In certain selected cases its use may be preferable for intra abdominal operations but in many of these instances a safer and more satisfactory anesthesia is obtained if an abdominal wall block is used as a supplement to intravenous anesthesia. When it is used to induce anesthesia prior to the administration of local regional or inhalation anesthesia an apprehensive patient may be spared much mental strain or physical discomfort. It may frequently be useful to supplement local or spinal anesthesia when the effect of the latter is beginning to wear off. For certain operations requiring the use of the electrocautery, intravenous anesthesia may be preferred to an inflammable or explosive inhalation anesthetic agent. Complications following the use of

intravenous anesthesia are rare. Phlebitis along the course of the vein employed or other irritative effects rarely if ever occur when 2.5 per cent solutions of pentothal sodium have been employed. Remote untoward effects and complications are conspicuously absent. Elderly and debilitated patients tolerate this type of anesthesia well, although much smaller doses usually are required. Most anesthetists agree that the method should not be used for operations in the vicinity of the pharynx, operations in which it will be difficult to maintain a free airway, in cases in which the blood and secretions may act as a potential obstruction to the airway, in operations in which profound and continuous muscular relaxation is desired, as in extensive intra abdominal operations, and in cases in which the patients are young children. A sulphur containing barbiturate, such as pentothal sodium, is not felt to be a safe anesthetic agent when a patient has been receiving another sulphur containing preparation, such as sulfanilamide unless the latter drug has been withheld for twenty four to forty eight hours.

A question which frequently arises is the advisability of employing intravenous anesthesia in private practice either in the home or the doctor's office. If the narcosis is to be brief not exceeding five minutes and if the physician insists that the patient lie down until the effects of the drug have completely worn off its use in the office may be permitted. Even when a patient appears to have completely recovered from the anesthetic, he should not be permitted to return home unless accompanied by a responsible person. Intravenous anesthetics should be administered with the patient in the prone position. Facilities for administering oxygen and carbon dioxide should be available, as these agents are most reliable in combating excessive respiratory depression caused by a barbiturate. Thus, with

the type of intravenous anesthesia available today, we have a method whose merits and safety have become established. The method of administration is comparatively simple and does not involve the use of complicated apparatus. Despite this fact, the method is safe only in the hands of those experienced in its use.

The importance of a thorough knowledge of the effects of the barbiturates and the method of administration cannot be stressed too strongly. Such knowledge will, of course, tend to increase the value and safety of this new method of anesthesia.

R. CHARLES ADAMS



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## REVIEWS OF NEW BOOKS

THE excellent book *Fractures of the Jaws* by Ivy and Curtis which now appears in revised edition will be a valuable addition to the library of not only the general practitioner but of the specialist as well. Its simple practical language not only deals with the simple problems but by directing easily applied treatment facilitates the management of the more difficult complications which do at times arise. It is comprehensive and concise and directs the application only of known and proved methods avoiding

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HENRY A. POTTS

*FRACTURES OF THE JAWS* By Robert H. Ivy M.D. DDS FACS and Lawrence Curtis A.B. M.D. DDS FACS 3d rev. ed. Philadelphia L. & F. 1935

## BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

*CLINICAL OBSTETRICS* By A. Lakshmanaswami Mudaliar B.A. M.D. F.R.C. Edinburgh and London Oliver and Boyd 1938

*SÁ MATERNIDADE CONSELHOS E SUGESTOES PARA FUTURAS MÃES* By Prof. Dr. Arnaldo de Moraes 2d ed. Rio de Janeiro Brazil Graphica Sauer 1938

*DIE UROLOGIE IN EINZELDARSTELLUNGEN* Edited by Prof. Dr. H. Boerninghaus *DIE HYPERTONIE DES NIERENBLASENSPINNAERTERS* By Prof. Dr. Hans Rubinius Leipzig Georg Thieme 1935

*DIE UROLOGIE IN EINZELDARSTELLUNGEN* Edited by Prof. Dr. H. Boerninghaus *SCHWANGERSCHAFTSUNTERBRECHUNG ALS UROLOGISCHE INDICATION* By Prof. Dr. B. Olz Leipzig Georg Thieme 1939

*DIE UROLOGIE IN EINZELDARSTELLUNGEN* Edited by Prof. Dr. H. Boerninghaus *DIE HAEMATURIE UND IHRE BEHANDLUNG* By Privatdozent Dr. Rudolf Chwalla Leipzig Georg Thieme 1939

*VERGEPLAZTE LAPAROTOMIE-NAEHE* 1ST 30 FALL ODER FREILEGEN DER EINWEIÐE By Alexander Gehl Leipzig Druck von Alexander Edelmann 1938

*ANATOMY OF THE HUMAN LYMPHATIC SYSTEM* By H. Rouvière A compendium translated from the original *Anatomie des Lymphatiques de l'Homme* by M. J. Tobias von Arbor Mich. Ld vards Brothers Inc 1938

*EVERYDAY SURGERY* By Lambert Rogers M.Sc. F.R.C.S. F.R.C.P. F.R.C.S. FACS and A. L. d'Abreu M.B. Ch.M. F.R.C.S. With an introduction by Professor G. Grey Turner D.Ch. M.S. F.R.C.S. F.R.C.S. FACS Baltimore William Wood & Co 1938

*THE ESSENTIALS OF MODERN SURGERY* Edited by R. M. Handfield Jones M.C. M.S. F.R.C.S. and A. I. Porritt M.A. M.Ch. F.R.C.S. Baltimore William Wood & Co 1938

*ALCOHOL IN MODERATION AND EXCESS A STUDY OF THE EFFECTS OF THE USE OF ALCOHOL ON THE HUMAN SYSTEM* By J. A. Waddell M.D. and H. B. Haag M.D. Richmond Va. The William Byrd Press Inc 1935

*A MANUAL OF FRACTURES AND DISLOCATIONS* By Barbara Bartlett Stimson A.B. M.D. Med.Sc.D. F.R.C.S. Philadelphia Lea & Febiger 1939

*A GLASGOW MANUAL OF OBSTETRICS* By Samuel J. Cameron M.B. F.R.F.P.S. F.R.C.O. John Hewart M.B. Ch.B. F.R.C.O. Robert A. Legge M.D. F.R.F.P.S. F.R.C.O. Ellen D. Norton M.B. Ch.B. M.C.O. 3rd ed. London Edward Arnold & Co 1939

*YODOVENTRICULOGRAMA (FOSA P. T. RICA)* By Dr. Ramon Carrillo Buenos Aires Frascoli y Bindi 1937

*LE TRAITEMENT NON SANGLANT DES FRACTURES DU RACHIS FRACTURES RECENTES—FRACTURES ANCIENNES TECHNIQUE ET RESULTATS* By Pierre Mallet Guy Paris Masson & Cie 1935

*FRATTURA CHIRURGICA* By Vittorio Puccinelli Bologna Italy L. Cappelli 1938

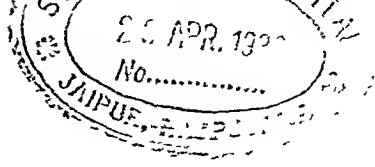
*TUMORI DEL RINF.* By Mario Pignatola and Mario Fernandez With a preface by Prof. G. B. Lasio Bologna Lucina Cappelli 1935

*THE DIAGNOSIS AND TREATMENT OF DISEASE OF THE THYROID* By James H. Means M.D. and Edward P. Richardson M.D. London New York Toronto Oxford University Press 1935

*HERTZLER'S MONOGRAPHS ON SURGICAL PATHOLOGY SURGICAL PATHOLOGY OF THE DISEASES OF THE MOUTH AND JAWS* By Arthur E. Hertzler M.D. Philadelphia Montreal and London J. B. Lippincott Co 1938

*INFECTIONS OF THE HAND A GUIDE TO THE SURGICAL TREATMENT OF ACUTE AND CHRONIC SUPPURATIVE PROCESSES IN THE FINGER HAND AND FOREARM* By Allen B. Karvel M.D. Sc.D. 4th rev. ed. Philadelphia Lea & Febiger 1939

*THE MEDICAL PRESS AND CIRCULAR 1839-1939 A HUNDRED YEARS IN THE LIFE OF A MEDICAL JOURNAL* By Robert J. Roulette M.D. F.R.C.P. London The Medical Press & Circular 1939



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*DIE UROLOGIE IN EINZELDARSTELLUNGEN*. Edited by Prof. Dr. H. Boerninghaus. SCHWANGERSCHAFTSUNTERBRECHUNG ALS UROLOGISCHE INDICATION. By Prof. Dr. H. Ottow. Leipzig: Georg Thieme, 1939.

*DIE UROLOGIE IN EINZELDARSTELLUNGEN*. Edited by Prof. Dr. H. Boerninghaus. DIE HAEMATURIE UND IHRE BEHANDLUNG. By Privatdozent Dr. Rudolf Chwalla. Leipzig: Georg Thieme, 1939.

*AUFGEPLATZTE LAPAROTOMIEWUNDEN MIT VORFALL ODER FREILIEGEN DER EINGEWEIDE*. By Alexander (Chike). Leipzig: Druck von Alexander Edchmann, 1939.

*ANATOMY OF THE HUMAN LYMPHATIC SYSTEM*. By H. Rouvière. A compendium translated from the original *Anatomie des Lymphatiques de l'Homme* by M. J. Tobias. Ann Arbor: Mich. Edwards Brothers Inc., 1939.

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*THE ESSENTIALS OF MODERN SURGERY*. Edited by R. M. Handfield Jones, M.C., M.S., F.R.C.S. and A. J. Porritt, M.A., M.Ch., F.R.C.S. Baltimore: William Wood & Co., 1938.

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*A GLASGOW MANUAL OF OBSTETRICS*. By Samuel J. Cameron, M.B., F.R.F.P.S., F.R.C.O. John Ifert, M.B., Ch.B., I.C.O.G., Robert A. Lennie, M.D., F.R.F.P.S., F.R.C.O., Ellen D. Motion, M.B., Ch.B., M.C.O.C., 3rd ed. London: Edward Arnold & Co., 1939.

*ODONTOENTRICOGRAPHIA (FOSA POSTERIOR)*. By Dr. Ramon Carrillo. Buenos Aires: Trascorchi y Bindi, 1937.

*LE TRAITEMENT NON SANGLANT DES FRACTURES DE RACHIS. FRACTURES RECENTES—FRACTURES ANCIENNES. TECHNIQUE ET RESULTATS*. By Pierre Mallet-Guy. Paris: Masson & Cie, 1938.

*PRATICA CHIRURGICA*. By Vittorio Puccinelli. Bologna: Italy: L. Cappelli, 1938.

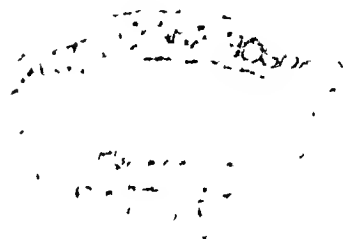
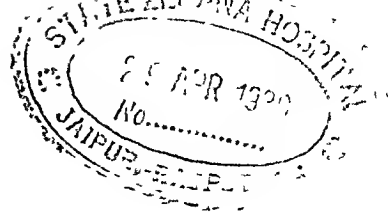
*TUMORI DEL RENE*. By Mario Pignatosa and Mario Fernandez. With a preface by Prof. C. B. Lasio. Bologna: Li Mo Cappelli, 1938.

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*HEFTZLER'S MONOGRAPHS ON SURGICAL PATHOLOGY. SURGICAL PATHOLOGY OF THE DISEASES OF THE MOUTH AND JAWS*. By Arthur H. Heftzler, M.D. Philadelphia: Montreal and London: J. B. Lippincott Co., 1938.

*INFECTIONS OF THE HAND. A GUIDE TO THE SURGICAL TREATMENT OF ACUTE AND CHRONIC SUPPURATIVE PROCESSES IN THE FINGERS, HAND AND FOREARM*. By Allen B. Kanavel, M.D., Sc.D., 7th rev. ed. Philadelphia: Lea & Febiger, 1939.

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# SURGERY

## GYNECOLOGY AND OBSTETRICS

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### EXCISION OF THE SUPERIOR HYPOGASTRIC PLEXUS (PRESACRAL NERVE) FOR PRIMARY DYSMENORRHEA

JOE VINCENT MEIGS, M.D., F.A.C.S., Boston, Massachusetts

FROM 1898 till 1924 attempts were made to relieve pain in the pelvis by section or excision of sympathetic nerves. Periaarterial sympathectomy was attempted by Leriche with some measure of success. In December, 1924, Cotte first performed the operation known as "presacral neurectomy." His patients' relief of pain was immediate and satisfactory so that in 1925 he reported his operation and its success. Since then many reports in foreign and domestic journals testify to the soundness of Cotte's operation. There have been few admitted failures and no report of sequelæ from excision of this part of the pelvic sympathetic system. The mortality is said to be almost nil and the operation reported as easy. Cotte emphasized certain definite types of cases that might be expected to be relieved by his operation and it is obvious from perusing the literature that few have deviated from his original standards. He reported in 1930 that the presacral nerve is one that spreads out exclusively in the pelvis and vaginal regions and that resection of this plexus of nerves is a cure for "plexalgia hypogastrica." This last term includes dysmenorrhea, dyspareunia, causalgia of the vagina, pelvic neuralgias, and pruritis vulvæ. It is definitely of no use for lumbar pains

(ovarian dysmenorrhea) or ovarian intermenstrual crises. But for pain referred to the uterus and radiating to the anus, coccyx, and urinary bladder, a properly done operation should be followed by a 100 per cent relief.

Various names are connected with the attempt to solve the problem of pelvic pain and a few follow Jaboulay, 1898; Ruggi, 1899; Leriche, 1921, Cotte, 1925. These men all contributed to the ground work of the operative procedure while Latarjet and Bonnet named the main nerve branches of the sympathetic system of the pelvis the "presacral nerve." Hovelacque re-named this nerve area and more properly called it the "superior hypogastric plexus." Later Elaut, Fontaine, and Herrmann, in 1932, contributed studies both anatomical and experimental to the problem.

In 1933, Davis undertook careful studies of the nerves themselves removed at operation for relief of pain. Cotte first suggested the possibility of an inflammatory process in the region of the pelvic sympathetic nerves as the reason for pelvic neuralgias, and the work of Davis substantiates it. One reason, among many others, suggested for pelvic neuralgias and for dysmenorrhea is that mild inflammatory processes are found affecting the connective tissue and the nerves themselves with degeneration occurring in the ganglion cells.

From the Surgical Service of the Massachusetts General Hospital.



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It must be acknowledged that certain dysmenorrheas are psychic or physical, and the better the condition of the patient's psyche and the better her physical condition the less likely she is to be bothered with pain. Nevertheless the number of patients relieved of true dysmenorrhea by either psychiatrists or hygienists is small. They may make it easier for the patient to bear her pain but they do not, except in a few instances, relieve it. The gynecologist should be on the watch for patients who do not have a typical story of true dysmenorrhea, for the operation will not help them and failure discourages the patient's physician. If it is evident that a patient has no complexes and that her physical condition is satisfactory and the dysmenorrhea is *uterine dysmenorrhea*, then real relief of from 75 to 100 per cent can be expected by removal of the plexus.

Before subjecting any patient to the operation, it is suggested that other methods of treatment be tried first, such as psychiatry; improvement in hygiene, the use of simple drugs, such as aspirin, antispasmodics, such as atropine or belladonna; and dilatation of the cervix. The use of morphine and its derivatives should not be considered. No doubt in the near future there will be reports on the use of hormones but all except huge doses of estrin with its probable effect upon ovulation have proved failures in our hands. It will have to be decided by the individual doctor and patient whether the surgical removal of the nerve is more hazardous than a possible disturbance of the pituitary gland by large doses of estrin. It is better in most instances to advise dilatation of the cervix before an abdominal operation inasmuch as this simple procedure does relieve 25 to 50 per cent of cases for an indefinite period. The presence of a thick muscular band about the internal os, similar to the band about the pylorus in pyloric stenosis of children must be considered. If such a band is felt on rectal examination, it can be split by cutting posteriorly in the cervical canal against the finger in the rectum. This method of longitudinal section of the internal os is important and if the cervix is exceptionally tight the incision should enlarge the os and give relief from pain. The use of

the stem pessary is a real possibility as it may be accompanied by a great deal of success and surely the dangers are not too great. This form of treatment can be tried by those who have no objection to it. If at operation a retroversion or flexion of the uterus is found, it is much better to do a suspension and also a neurectomy than it is to find after the suspension that the patient is not relieved of her pain.

#### ANATOMY OF THE NERVES

"The superior hypogastric plexus is a sympathetic plexus and the preganglionic fibers come from the lowest thoracic and upper lumbar levels of the intermediolateral columns. The cells send their axones out over the lower white rami of the thoracolumbar outflow to the lumbar and pre-aortic ganglia. The postganglionic neurones originate in the sympathetic trunks, as well as in the pre-aortic ganglia, to form a plexus descending along the abdominal aorta. At the level of the inferior mesenteric artery there are two small ganglia and from these a plexus descends the artery to innervate the sigmoid and rectum. The remainder of the descending sympathetic fibers form the superior hypogastric plexus at the bifurcation of the aorta. This plexus divides at the bifurcation of the two common iliac arteries to form two hypogastric nerves that run into the hollow of the sacrum to join the inferior hypogastric plexus. Sensory neurones from the posterior root ganglia in the same segments of the cord run directly into the superior and inferior hypogastric plexus" (White). In other words, from the celiac, semilunar, splanchnic, and mesenteric ganglia sympathetic fibers course down either side of the aorta (the intermesenteric nerves) and often crossing and recrossing the aorta are joined by branches from the lumbar ganglia (Fig 1). At the region of the root of the inferior mesenteric artery as it arises from the aorta a plexus is found known as the inferior mesenteric plexus. Some of the nerves making up this plexus follow the inferior mesenteric artery to supply the sigmoid and rectum, and others course down over the bifurcation of the aorta to form the superior hypogastric plexus. This plexus lies in the triangle bounded by the two common iliac





meters If this injection is done bilaterally and 5 to 10 cubic centimeters of 2 per cent procaine deposited through each needle, it will result in anesthesia of the superior hypogastric plexus If this preliminary test could be carried out in all patients with severe dysmenorrhea there ought to be no failure (except for inexpert surgery) and cases not suitable for this type of surgery would be excluded

### THE OPERATION

The operation itself has been reported as both easy and fairly difficult After doing over 30 I believe that it is not difficult but that it requires considerable patience and painstaking dissection As it is often said to be combined with the operation of abdominoperineal resection for carcinoma of the rectum by various surgeons it would seem easy to do I believe that it cannot be satisfactorily done if combined with any long and difficult operation such as abdominoperineal resection for carcinoma of the rectum, for it should take about an hour to do the neurectomy well Success depends upon the removal of all nerve fibers, even the very small ones, and if they are not entirely removed recurrence of pain may be expected The operation is done with the patient in Trendelenburg position and the incision is made from about the symphysis to just above the umbilicus (In women who have had children a midline incision is made but in those with no children a paramedian incision is best) The pelvic organs are carefully inspected for evidences of pathology, and it is especially important that evidences of endometriosis be sought for, since this entity is so often accompanied by acquired dysmenorrhea The intestines are well walled off and the posterior peritoneum from the bifurcation of the aorta into the true pelvis is exposed This peritoneum is picked up with forceps just below the bifurcation and a small incision is made into it With scissors the loose areolar tissue of the retroperitoneal space is dissected off the under surface of the peritoneum The opening in the peritoneum is from 10 to 15 centimeters in length It is well to place three or four silk stay sutures along the edge of the peritoneum to be used as retractors As the tissue on the right side is

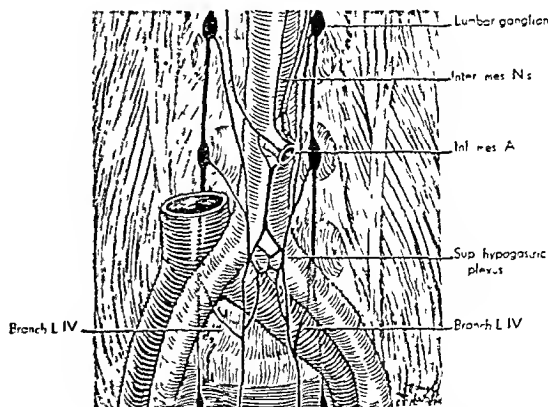


Fig 1 This drawing shows the origin of the superior hypogastric plexus (presacral nerve) from sympathetic fibers coursing along the aorta arising from the splanchnic, semilunar, and other higher ganglia and from the lumbar ganglia Notice that the branch from the fourth lumbar ganglion passes under the common iliac arteries and not over the bifurcation of the aorta, as most of the plexus does This is a very important technical point

released the right common iliac artery is exposed Gently with scissors or with small bits of gauze held in hemostats the areolar tissue, connective tissue, and nerves are freed from their connections with the common iliac arteries from the bifurcation of the aorta to the bifurcation of the iliacs The large left common iliac vein is located directly posterior in the triangle Great care must be used for a tear in this vein might be disastrous Occasional small venules arise from it that are easily torn and these should be clamped and tied The right common iliac vein is not seen as it lies to the outer side of the right common iliac artery A piece of tape is then threaded under the mass of tissue to be removed and traction made upon it The dissection is carried up to the bifurcation of the aorta or just above it, and the tissue is clamped and the proximal part is tied This mass of tissue is then pulled downward and carefully dissected free as far down as the bifurcation of the common iliac arteries on both sides Here the plexus is clamped and removed and the distal end is tied The triangle should now be bare from the bifurcation of the aorta to the bifurcation of the common iliacs (Fig 2) The left iliac vein is clear of all small fibers as is the periosteum and the perichondrium of the fifth lumbar vertebra The right ureter

arteries and originates at the bifurcation of the aorta and ends at the bifurcation of the common iliac arteries to become the right and left hypogastric nerves. Some fibers follow the common iliac arteries and are intimately connected with them. The left common iliac vein forms the back wall of the triangle and the nerves are often in close association with it. It must be remembered that from under the common iliac arteries branches of nerves from the fourth lumbar ganglia come to join the plexus. All other nerves cross over the bifurcation of the aorta but these two branches are under and must be remembered when doing the dissection. Low down the superior hypogastric plexus lies directly upon the penostem and perichondrium of the fifth lumbar vertebra and just above the vertical middle sacral artery. The two hypogastric nerves are joined lower down in the pelvis by parasympathetic fibers of the second, third, and fourth sacral ganglia and make up the inferior hypogastric plexuses. These nerves supply the uterus and bladder and end in the uterus in the great plexuses of Frankenhaeuser.

#### PHYSIOLOGY OF THE NERVES

It has long been considered that the pelvic nerves were motor and carried no sensory fibers, but the success of presacral neurectomy and the great relief of pain increase belief in the presence of sensory fibers. Learmonth's observation supports this view. With a patient under spinal anesthesia he noted that banding the superior hypogastric plexus with forceps caused crushing pain in the bladder. The sympathetic fibers cause vasoconstriction and inhibition of the musculature of the sigmoid, rectum and bladder and cause ejaculation and contraction of the involuntary sphincters of the bladder. The parasympathetic works in opposition to the sympathetic nerves and causes vasodilatation and release of the various sphincters. It is, therefore, possible to conceive of a better blood supply to the uterus and a release of muscular tone both in the body and the cervix by excision of the superior hypogastric plexus. This alone might account for certain pain relief, but the fact that section of these nerves does not alter (to any great degree) the menstrual function, does not inter-

fere with delivery, does not produce atrophy or cause any disturbances of motor function of the bladder seems to Fontaine and Herrmann to be supportive proof that the genital nerves of the sympathetic systems are sensory rather than motor in nature. The hypogastric plexus carries pathways of sensation from the genital tract to the medullary centers, and excision of this plexus is therefore sound in the treatment of uterine or cervical pain.

Thus we have a system of sympathetic nerves that course through the superior hypogastric plexus and that carry vasoconstrictor fibers to the blood vessels of the uterus and cause contraction of certain sphincter muscles. The nerves also carry afferent sensory impulses to the higher centers. Excision of such a plexus therefore should cause increase of blood supply, lessening of spasm and interruption of pain impulses to higher centers. The parasympathetic in opposition to the sympathetic supply dilates blood vessels and releases sphincters, does not carry uterine pain, but does carry bladder pain. Thus removal of the superior hypogastric plexus seems to have a firm foundation physiologically.

Before the operation is described and the results in the two groups of patients are given, the type of cases chosen for the operation should necessarily be considered. In our experience (and it is only in cases of dysmenorrhea) it is essential that only those cases with a clear cut history of true primary dysmenorrhea should be considered. If there is any doubt as to the diagnosis, this operation should not be performed. In one of our cases we voiced the suggestion that the patient was not the right type and she has since had no relief of her pain and a subsequent delivery was more painful than ever. This should not be so. Flothow has discovered a test for checking the pain of dysmenorrhea by injection of a per cent procaine into the region of the plexus. The second and third lumbar ganglia are injected. He inserts a needle at the level of the fourth lumbar interspace 7 centimeters from the midline at an angle of 45 degrees until the upper portion of the body of the fifth lumbar vertebra is encountered, then advances the needle over the anterolateral surface of the body of the vertebra for a distance of about 1.5 centi-

through the internal os. Following the operation, dilatation was continued in the office regularly but complete relief was never obtained. However, gradual improvement has occurred so that in April, 1938, the patient can do her daily work and does not remain at home as previously during her period. Nausea was completely relieved by the neurectomy but pain was not. A good deal of her later pain was in the form of backache which was not present before the operation. It is possible that the backache is due to the necessary stretching of the cervix. Incidentally this patient has had much less flow than usual and the period is of shorter duration since her operation. The third patient, Case 16, was operated upon in October, 1936. In January, 1937, she was considerably improved and felt pleased. In June, 1937, she regarded the operation as unsuccessful, with perhaps 10 per cent relief. In March, 1938, she had been having about 40 per cent relief for the past 6 months. She believes that she is now beginning to obtain some relief. She has had no treatment since the operation. This case cannot be regarded as a success.

One of the partial failures should not have had the operation at all as she did not have true dysmenorrhea. Another patient (Case 10), with only a slightly satisfactory result was operated upon in December, 1935. She was judged a questionable candidate for neurectomy before operation. In July, 1936, she stated that the operation was fairly successful giving her about 50 per cent relief. In December, 1936, she reported the operation as partially successful, still with 50 per cent relief. In 1937 she was operated upon again and a uterine suspension was done in another hospital. Following that she had a baby. The birth of the child was very painful and the neurectomy gave her no relief of pain during the delivery. In July, 1938, she reported 30 per cent relief. She has had severe headaches and nausea before her periods for the last year. This patient probably has had relief but will not admit it for she is very disappointed that she was not sterilized and that she has had another child. She is now anxious to be operated upon again; she wishes to be sterilized and hopes her uterus will be removed so she

TABLE I.—PRESACRAL NEURECTOMY ALONE

Case Year	Result
1 1930	No pain for 5 years. Recurrence of mild pain. Complete relief again.
2 1932	No relief. Dilatation and curettage done in July, 1933. Relief obtained. Pain returned 5½ years after operation.
3 1934	Complete relief.
4 1934	Complete relief.
5 1935	Complete relief. Married. Intercourse satisfactory.
6 1935	Complete relief for 1 year, then return of pain 3 years after operation. Relief again obtained. Married. Intercourse not satisfactory.
7 1935	No relief. Dilatation and curettage necessary later. Gradual improvement.
8 1935	Partial relief for 1 year, then return of pain. Relief again 2 years after operation.
9 1935	Complete relief at first. Three years after operation slight amount of pain recurred. Married. Intercourse not satisfactory. One child. Pain slightly less severe than average primipara.
10 1935	Fair amount of relief. Two years later suspension done. Intercourse not satisfactory. Child born. More pain than usual with delivery.
11 1936	Complete relief.
12 1936	Partial relief for a few months. One year later, complete.
13 1936	Complete relief. Married. Intercourse not satisfactory. One child. Rhythmic backache. No abdominal pain.
14 1936	Complete relief.
15 1936	Partial relief.
16 1936	Considerable improvement for a few months, then return of pain. Is beginning to obtain some slight relief.
17 1936	Complete relief of dyspareunia and dysmenorrhea.
18 1937	Complete relief.
19 1937	Some relief. Very much better in 1938. Subsequent endometrial biopsy caused no pain.
20 1938	Some relief. Getting much better.

can be sure she will have no more children. This case should not be regarded as a failure, but it is a failure as far as the patient is concerned.

*Postoperative course.* The postoperative course in all patients has been entirely satisfactory. None of them had more difficulty than in other abdominal operations. There have been no more postoperative catheterizations and no more difficulty with obtaining bowel movements than in any other abdominal operative procedure.

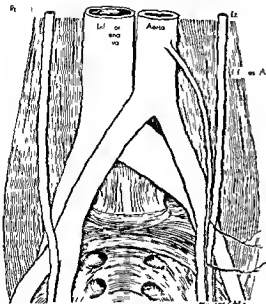


Fig. 2. At the end of the neurectomy the triangle bounded by the bifurcation of the aorta and a line drawn from the bifurcation of one common iliac to the other with the left common iliac vein and the vertebra as the back ground must be cleared of all nerve fibers.

has been bared for the whole distance. The left ureter is not always seen in this operation. Care should be taken to make sure that branches from the fourth lumbar ganglia that are found in the triangle under the common iliac arteries are identified and severed (Fig. 2). All suspicious fibers in the triangle should be removed and the area should appear as is shown in Figure 2. No shreds or doubtful pieces of tissue should be left. It is sometimes necessary to tie the middle sacral artery. All ties are of fine silk and the opening in the peritoneum is closed with a continuous suture of silk. Operations for other pelvic pathology should be done either before or after the neurectomy, depending upon which is the more important operation. If the section of the nerve is most important, plenty of time should be allowed for the procedure. It must not be hurried. There is no doubt but that all pelvic pathology should be removed and malpositions should be corrected as a part of the operation. Results from neurectomy alone are not so good as those done combined with necessary pelvic surgery. Occasionally the

operation is more difficult due to the position of the left mesocolon, usually it can easily be drawn aside but occasionally it crosses the field of operation in such a fashion as to render approach to the plexus impossible.

#### RESULTS

Results vary, both in the opinion of the patients and in the opinion of the surgeon (Table I). Patients often forget how much better they are on the whole and base their entire judgment on their feeling at their last period. A later letter or a later interview following a few easy periods discloses a change in the patient's judgment; the particular discomfort is gone and she is well again. Therefore, it seems wiser for the surgeon to present his opinion rather than to have the patient do so. In this series of 20 patients that had a presacral neurectomy without any other pelvic surgery 15 of them, or 75 per cent, had a successful result. Two patients, or 10 per cent, had a partially successful result. Three cases were complete failures. The percentages of relief are as follows: four, 100 per cent, five, 90 per cent, one, about 80 per cent, four, 70 per cent, two, 50 per cent, one, 30 per cent, and the three others failures. In 1 failure Case 2 patient was operated upon in August, 1932. In July, 1933 dilatation was done to attempt relief of the same pain. Up to November, 1936, the relief, according to the patient, was about 90 per cent. Her periods were of shorter duration, one to two days late or early. In January, 1938, cramps started again commencing 2 weeks before the flow began. Examination of the cervix showed that it was open and could be easily dilated in the Out Patient Department up to a No. 16 uterine dilator. A letter from the patient in March, 1938, stated that the cramps were no different than before the operation and that the flow was of shorter duration. Another patient Case 7 was operated upon in July, 1935, and failure was due in the author's opinion to the fact that the cervix was so tight that the menstrual flow could not possibly drain well. Her dysmenorrhea was due to a mechanical block. It was necessary at a later date to dilate the cervix. One hour was spent before the finest cervical probe could be passed.

A third patient, Case 10, who has been reported as having an unsatisfactory result states that she had more pain than ever during her delivery. She had only a moderate amount of relief from the presacral neurectomy and from a later suspension of the uterus. This patient has a complex about pregnancy, and it is hard to credit her report about this delivery.

#### OTHER OPERATIVE PROCEDURES PLUS PRE-SACRAL NEURECTOMY

Seven patients had other operative procedures besides the presacral neurectomy. Of these 6, or 85.7 per cent, report complete relief. This is a very excellent report. One patient was not relieved, but she is so "mothered" by her mother who suffers every pain with her that it is impossible to state whether or not the operation was successful. Letters are received from her regularly every month and about 6 periods a year are painless, and 6 are painful. Her pain when present is said to be worse than it has ever been before. All 6 patients of this group who obtained relief claim it to be 100 per cent. In 3 there was a change in the periods—more regular in 1, slightly shorter duration and smaller in another, and irregular in a third. There was no change in 4. There were no urinary difficulties. Constipation was noted following the operation in one, and another had diarrhea. In 5 there have been no bowel symptoms.

In 6, there was postoperative bleeding. One patient's bleeding started 10 days following the onset of the last period. One went 38 days following the last period and a biopsy at operation showed a proliferative or estrin phase of endometrium. This patient may have had dysmenorrhea without ovulation, a rare occurrence. Two, or 28.6 per cent, of this group had a late change in periods.

Three of the patients had treatment before operation. One had emmenin, aspirin, and viburnum, the second, large doses of progynon, and the third, midol, progynon, and a dilatation. In 4 cases there is no record of the previous treatment. All patients were sent in by their local physicians and doubtless had had medication before coming to the hospital for surgery.

#### CONCLUSIONS

1 Resection of the superior hypogastric plexus or presacral nerve reduces uterine spasm and vasoconstriction. With these motor fibers there are others that are sensory and carry uterine pain to the central nervous system. Section of this nerve therefore should decrease spasm and permit dilatation of the blood vessels in the pelvis and uterus and should relieve pain sensation. To whatever cause one may attribute pain in dysmenorrhea, it is possible after consideration of the physiology of the nerves to expect relief from the section of them. This it certainly does in a large percentage of cases.

2 It is evident that this operation, which is eminently successful, depends upon proper choice of patients for operation. A patient with uterine dysmenorrhea referred to the region of the anus and coccyx and not into the lumbar or ovarian region, is likely to have relief. A patient with a questionable type of dysmenorrhea, especially the type that might be confused with ovarian dysmenorrhea, should obtain no relief.

3 The operation causes a change in menstrual habits in a considerable number of patients—more than has been reported by other surgeons. These changes are not serious, nevertheless they can be expected and the patient should be so warned.

4 The opinion of the surgeon is a better criterion of relief than the opinion of the patient, because as noted in the long follow-up of these cases, pains and sensations in the pelvis vary and the patient may interpret them incorrectly whereas the surgeon with the entire record at hand can better evaluate the end-result.

5 It is obvious that correction of all pelvic pathology is better than presacral neurectomy alone.

6 Backache is not always relieved. One patient who had complete relief of abdominal cramps still had backache during delivery. Backache apparently is not controlled by the superior hypogastric plexus.

7 Pregnancy is not interfered with inasmuch as out of 5 marriages 3 pregnancies occurred and were successfully terminated. One had absolutely no rhythmic abdominal pain.

*Postoperative bleeding* In 8, or 40 per cent of the patients, postoperative bleeding was noted directly following the operation. In one it occurred immediately following operation, in one 5 days later, in two, 4 days, in two, 3 days and in two, 2 days. All patients were a considerable time postmenstrual. One biopsy showed a secretory phase 25 days after the last period, which is normal. In 4 or 29 per cent, there was no postoperative bleeding. In one of these the endometrium was in the proliferative stage at the time of the operation. In 8, or 40 per cent there was no record as to whether or not there was any postoperative bleeding.

*Change in catamenia* Nine patients had a change in their menstrual periods following the operation. One was more frequent, 3 of shorter duration, 2 had less flow, and 3 became irregular. In 9 there was no change, and in 2 the result could not be ascertained.

*Urinary changes* In 5 patients there was definite difference in urination. One had less frequency than before. In two a mild cystitis developed due to catheterization. In one urgency persisted 7 years after operation. In one there was change but exactly what could not be determined. In 13 there were absolutely no urinary changes, and in 2 it was not recorded.

*Changes in bowel habits* Four patients complained of more constipation than before the operation. In 14 there were no bowel changes. In 2 patients this could not be ascertained.

*Previous treatment* Different types of treatment were given the patients before the presacral neurectomy was contemplated. Dilatation was done in 4, dilatation with suspension in 2, a suspension in 1, dilatation, suspension, and oophorectomy in 1 other. Hormones (proluton, progynon, antuitrin S) were given to 5 patients in sufficient amounts without help. In 6 medicines and various other types of treatment had been tried without success. In 2 patients a pessary had been used. These patients were not relieved by their treatment and therefore neurectomy was decided upon. In 5 patients no previous treatment is mentioned in these records. It is our policy not to operate on any patients who have not had previous treatment.

Four patients, or 20 per cent, obtained late partial relief. One had a nervous breakdown  $1\frac{1}{2}$  years after operation and another following marriage. Six obtained no relief from their backaches. Inasmuch as the 3 patients who later became pregnant and gave birth to a child had backache it is evident that backache will not be relieved by presacral neurectomy and that the sensory nerves responsible for backache are different than those causing uterine dysmenorrhea. Four patients, or 20 per cent, had complete relief at first and later as learned from their letters, had only partial relief. Our first patient had a recurrence 5 years after operation only to have the pain disappear again 6 months later. Five, or 20 per cent, have had a late change in their periods. The change in periods is probably no greater than it is in a normal group of women, nevertheless these facts must be recorded.

*Pathology* In every instance the tissue removed showed nerve fibers. It is interesting to note the various findings of the pathology department—small nerve trunks, small sympathetic ganglion, nerve bundles and ganglia, lymph nodes, ganglion cells, clusters of nerve cells like sympathetic ganglion, etc.

*Marriage and pregnancy* Five married patients have been interviewed as to whether or not intercourse has been satisfactory. In 4, or 80 per cent it has not, and in 1, or 20 per cent, it has been. This is important because there may be some interference with the nerve supply of the vagina following this operation. Further accurate figures are necessary to prove this point, as in private practice only about 50 per cent of women have satisfactory intercourse. It is impossible to make a definite statement in regard to this important point. Five patients have married since the operation and 3 have had children. One with only 60 per cent relief from operation had a normal delivery. She and her doctor felt that her pains were slightly less severe than for the average primipara. One patient who had 100 per cent relief from dysmenorrhea had absolutely no abdominal pain of any kind during delivery but did have rhythmic backache. Here again it is evident that backache is not relieved as are uterine cramps by means of resection of the superior hypogastric plexus.

# A CONSIDERATION OF CERTAIN TYPES OF BENIGN TUMORS OF THE PLACENTA

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**B**ENIGN tumors of the placenta are relatively rare. With R. Drummond Maxwell one may readily agree that outside of hospital practice and a university clinic they are seldom if ever seen. Interest centers chiefly about the pathological anatomy and especially the histological structure. The striking variability of the microscopic pattern has been and still is the source of a great deal of confusion in nomenclature. Today these tumors are more commonly known as chorio-angiomas. Though the histogenesis seems to be fairly well established, opinion is still at variance as to whether chorio-angiomas are true tumors or not, while clinically they do not appear to be as important as was formerly thought. It is a collection of 8 such tumors in the pathological laboratory of our clinic that prompts a report and further consideration of the subject, more especially with regard to the interpretation and differentiation of the various types into which these tumors may develop.

## HISTORICAL BACKGROUND

The first benign tumor of the placenta found in the literature was reported by John Clarke, in 1798. His description and comment relating to the tumor leave little doubt that it was probably a chorio-angioma although he gave it no designation. The first instance of such a tumor in American literature did not appear until Emil Ries reported his observation in 1904. Virchow, in 1863, designated the tumor as *myxoma fibrosum chorii*, an appellation which frequently has been used by many who have been influenced and have followed this scientific luminary. From about 1880 to the present time it seems that every other additionally reported placental tumor falling into

this category has received a new or modified designation, so that an approximation of the number reveals that the same tumor depending upon its type and interpretation has inherited about 30 diverse designations. As far as it has been possible to determine, Beneke in 1900, first employed the term "chorio-angioma." Without enumerating the many others, we favor this term as being the one best suited to the tumor in the light of its histogenesis.

Reports of the occurrence of this tumor tend to show that it is comparatively rare. From earlier studies (Albert, Leopold, Kuehnell) the occurrence was noted once in from 7,000 to 9,000 deliveries. In the New York Lying-In Hospital, following 20,000 successive deliveries, the recognition of chorio-angioma was realized on 6 occasions or approximately a little less than once in 3,500 cases. It should be indicated, however, that 2 factors tend to make its appearance in the literature infrequent. Undoubtedly, there are some that are recognized but remain unreported, and in the second place, and of more importance, there are many which, because of their small size and their position deep in the substance of the placenta, are unrecognized and remain undiagnosed. Siddall lends support to the second circumstance by one of his studies. He hardened, sectioned, and carefully examined 600 placentas. Among them he found 6 instances of chorio-angioma, obviously demonstrating that had the placentas not been subjected to a very minute inspection they would have been discarded as negative.

In surveying the literature Szarthy, in 1934, collected 238 cases of chorio-angioma, the largest thus far reported. While the list of authors mentioned in the text appears only as references at the end of this paper, it should be pointed out that during the course of this study it was necessary to consult 195 references. Though we are aware that some may

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but did have backache another had less pain, and a third patient, who was conceded to be a failure as far as the operation was concerned had no relief

8 Intercourse may be interfered with since only one of the five married patients had successful orgasm. However, the cases are so few that no definite statement can be made now

9 Occasionally pain recurs for a short time in spite of complete relief

10 There are no serious changes in bladder or bowel habits

11 Finally, it seems obvious that this operation which appears formidable, is apparently the best form of treatment for patients with true primary dysmenorrhea

#### REFERENCES

- 1 CORRE G La sympathectomie hypogastrique a t elle sa place dans la thérapeutique gynécologique? Presse méd 1925 33 98
- 2 Idem Sur le traitement chirurgical des dysménorhées rebelles par la résection du sympathique pelvien J méd franc 1928 17 393
- 3 Idem Résection du sympathique pelvien Gynec et Obst 1931 23 233
- 4 Idem La chirurgie du sympathique pelvien en gynécologie J Internat de Chir 1936 1 160
- 5 Idem Resection of the presacral nerve in the treatment of obstinate dysmenorrhea Am J Obst & Gynec 1937 33 1034

- 6 DE COURCY J L Resection of the presacral nerve for dysmenorrhea Am J Surg 1934 23 408
- 7 ELALT L The surgical anatomy of the so called presacral nerve Surg Gynec & Obst 1932 35 381
- 8 FLOTHOW P G The relief of pelvic pain South Surgeon 1935 4 207
- 9 Idem Recent developments in surgery of the sympathetic nervous system South Surgeon 1937 5 60
- 10 Idem The superior hypogastric plexus and its relation to gynecology West J Surg Obst & Gynec 1917 45 70
- 11 LONTARNE RENE and HERRMANN LOUIS C Clinical and experimental basis for surgery of the pelvic sympathetic nerves in gynecology Surg Gynec & Obst 1932 54 133
- 12 HONELLACQUE A Anatomie des nerfs crâniens et rachidiens et du système grand sympathique chez l'homme Paris C Deoin 1926
- 13 JABOULAY M Le traitement de la névralgie pelvienne par la paralysie du sympathique sacré Lyon Méd 1899 90 102
- 14 LATARJET A and BONNET P Le plexus hypogastrique chez l'homme Lyon chir 1913 9 619
- 15 LEARMONTH JAMES R The value of neurosurgery in certain vesical conditions J Am M Ass 1931 95 632
- 16 LERICHE R Essai de traitement du krouros vulvaire par la sympathectomie de l'artère hypogastrique Bull et mém Soc de chir de Par 1921 47 1130
- 17 RUCCI G La simpatectomia abdominale utero-ovarica come mezzo di cura di alcune lesioni interni negli organi genitali della donna Bologna N Zinichelli 1899
- 18 WHITE J C The Autonomic Nervous System Anatomy Physiology and Surgical Treatment New York The Macmillan Co 1935



Fig 5 Case 2 Illustration of a capsule consisting of a few if any connective tissue fibers and a single layer of syncytium-like epithelium  $\times 120$

The color of the predominantly vascular tumor is a deep bluish-red, whereas that of the more cellular type is a grayish-red. On bisection, the cut surface simulates the appearance of the liver, spleen, or renal cortex, and may show a single or multilobular structure whose units are divided by fibrous connective tissue trabeculae. Often the combination and variation of the 2 types give the surface a mottled appearance.

The consistency of the tumor is uniformly firm approaching in many instances that of a fibroma. The vascular connection of the chorio-angioma with chorionic blood vessels or directly with those of the umbilical cord is established by the larger vessels of the tumor. Occasionally the communication between the tumor and the blood vessels of the umbilical cord is represented by a well defined vascular pedicle.

*Microscopic appearance* The great variety of microscopic pictures is such that it has caused a striking confusion in nomenclature. This is due to the variability in position, amount, condition, and degree of development of the blood vessels, and connective tissue elements which make up the various histological patterns seen in different chorio-angiomas or even in the same tumor.

All chorio-angiomas are well circumscribed. Some are encapsulated by a thin or thick layer of connective tissue fibers covered usually by a single layer of syncytium (Fig 4), others are



Fig 6 Case 3 Illustration of the so called pseudocapsule enveloping a chorio-angioma of the degenerated type  $\times 120$

simply invested by a single layer of syncytium-like epithelium (Fig 5). The tumors which are not as well preserved or show different degrees of degeneration are bordered by a comparatively thick, partly hyalinized, fibrinoid tissue in which swollen, vacuolated, and degenerating chorionic epithelium is enmeshed (Fig 6). This is the pseudocapsule referred to by many writers. In reality it is formed by the agglutination of the degenerated epithelium of the adjoining and surrounding compressed chorionic villi to the surface of the tumor, the syncytial epithelial covering of which has in great part disappeared. Whether by their capsule or pseudocapsule, chorio-angiomas are always sharply demarcated from the surrounding placental tissue.

The most common type of chorio-angioma is characterized by the following components: a more or less loose groundwork of chorionic stromal cells, predominantly ovoid in shape, supports numerous small blood vessels and capillaries. These vessels, for the most part, are dilated and filled with blood cells and are generally lined with a single layer of endothelium (Figs 7 and 8). They are uniformly or diffusely distributed throughout the tumor, or arranged in clusters, or again may be confluent.



Fig 1 Gross specimen from Case 8 showing the chorio angioma on the fetal surface extending from the margin to the insertion of the cord

have been overlooked or entirely missed, we believe that these are almost fully representative of the bibliography on chorio-angioma. In a careful check every care was taken to avoid reduplication of case reports and to exclude those which apparently were incorrectly diagnosed. It was possible then to bring the total number from the literature to 209 instances. The addition of our own 8 cases produces a new total of 217 reported chorio angiomas.

#### ***PATHOLOGICAL ANATOMY***

*Gross appearance.* There is considerable variation in the size of these tumors. They may range from one, the smallest diameter of which measures about 0.5 centimeter, while another may have a diameter of 22 centimeters. The



Fig 3 Cross section through the chorio angioma of Case 5 representing the cellular type



Fig 2 Cross section of the placenta from Case 4 showing a well circumscribed chorio angioma of the vascular type. One also sees connective tissue trabeculae extending through the substance of the tumor

dimensions of the average sized chorio angioma will vary from about 2 by 3 by 3.5 centimeters to about 4 by 5 by 8 centimeters. Generally the tumor is solitary, but multiple ones have been described. The shape is usually round to oval, and may be nodular or lobulated, while the surface is usually smooth. The tumor is always invested by a capsule or, as some interpret it, a pseudocapsule and may be readily enucleated from the adjoining placental tissue.

Ordinarily the fetal surface is the site of predilection, however, many are located on the margins and others are found buried in the substance of the placenta. Some are found protruding from the maternal surface and a very few have been noted at the base of the umbilical cord entirely separated from the placenta proper.



Fig 4 Case 4. A capsule of connective tissue fibers covered by a single layer of syncytium.  $\times 120$



Fig 10 A higher power from Case 5 showing the embryonal character of the cells  $\times 235$

blood vessels and epithelial lining of the tumor, reduction in number, or absence of blood cells in the capillaries may give certain areas or the greater part of the tumor an areolar or myxomatous appearance (Fig 13). In addition, these may be accompanied by calcareous, fibrinoid, or hyaline changes.

In any of these 3 types we have failed to appreciate a sufficient preponderance of fibrous connective tissue such as would justify an adherence to the designation of fibroma in connection with these chorio-angiomatic tumors. A consideration of the histogenesis will tend to support this exclusion.

# HISTOGENESIS

The resemblance of the components of chorio-angioma to the blood vessels and stroma of the normally developing chorionic villus unquestionably points to their origin from the chorionic mesenchyme, the common source of endothelial and connective tissue. That there is a close embryogenetic relationship between endothelium, connective tissue, and blood cells is fairly well established. One is able to note in the cellular or more immature type of chorio-angioma the process of transition from the embryonal type of mesenchymal cells into more adult types of endothelial and stromal cells.

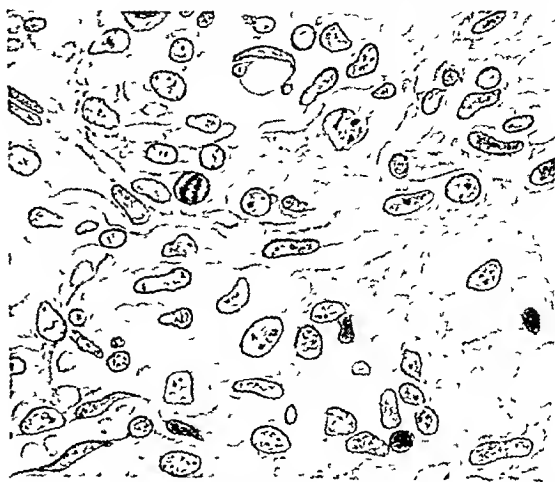


Fig 11 A camera lucida drawing from an area in specimen from Case 5 illustrating collapsed capillaries and interstices lined with endothelial cells. The greater part of the cells, both endothelial and stromal, have a more immature appearance. One sees an endothelial cell in mitotic division  $\times 750$

The proliferating endothelium assumes at once the predominant rôle. Ultimately the development and growth progresses to complete angioma formation with the stroma playing only a subordinate or accessory rôle. Beaufays describes and discusses this succession of developments very well in his report of

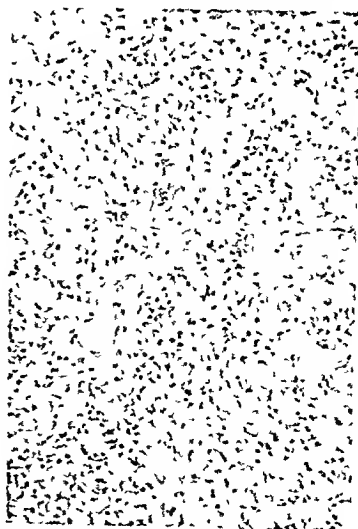


Fig 12 Case 4 An area illustrating transition from the cellular to the vascular type  $\times 120$



Fig. 7. Case 2. A typical area of the mature or vascular type of chorio-angioma with practically all capillaries and blood vessels dilated and filled with red blood cells.  $\times 120$

ent so that a somewhat cavernous structure results. Fibrous connective tissue trabeculae carrying blood vessels of varying caliber are seen working their way through the substance of the tumor dividing it into lobules of diverse sizes. This description applies particularly to the predominantly vascular or the more mature type.



Fig. 8. A camera lucida drawing from a small area in Figure 7 illustrating the capillaries dilated with red blood cells and lined by a single layer of endothelium. One also notes the loose connective tissue groundwork and stromal cells.  $\times 750$



Fig. 9. Case 5. A typical area of the cellular or immature type of chorio-angioma. This is the type that has the fibromatous or sarcomatous appearance.  $\times 120$

A less common type is that which is composed of more cellular elements. Such tumors consist of an abundance of endothelial and chorionic stromal cells many of which are quite embryonal in character. The structure at once impresses one as being very compact. Closer scrutiny will disclose that many of the endothelial cells are lining interstices and small blood vessels which are obviously collapsed (Figs. 9, 10, and 11). Transition from these compact cellular areas to small isolated angiomatous areas with dilated capillaries filled with blood cells is noted (Fig. 12). This profusion of embryonal mesenchymal cells differentiated into young chorionic stromal cells and endothelium with occasional mitotic activity represents the more immature type of chorio-angioma. Beaufays has recently described and designated such a tumor as a mesenchymal angioma of the placenta. Between these 2 characteristic extremes it is obviously possible to obtain many combinations of the vascular and cellular constituents.

A third type is distinguished by various degrees of degeneration, a process which is naturally expected to be secondary to any primary growth. Interstitial edema swelling and vacuolization of stromal cells, degeneration and disappearance of the endothelial lining of the

demic inclinations. With the knowledge and criteria at present available we are of the opinion that one cannot say with any finality that benign tumors of the placenta are true tumors even though the greater number of writers are inclined to believe that they are

It is unnecessary to go into the details of some of the older theories which were advanced to explain the origin of chorio-angiomas. Most of them are now considered untenable. However, some mention of these theories does appear essential for the sake of completeness. Danyau and Goodhart speculated that their origin could be traced to organized blood clots. Albert and Dienst supported the idea that these tumors originated from vessels derived from the allantois. Many others considered an inflammatory basis as their source (Plauchu and Savy, von Mars, Lonnberg, Berglund, Le Page, Solowij). Chorio-angioma, the result of degeneration and necrosis, was advanced by Grafenberg and Hildebrand. Storch, Mertens, and Gueniot proposed that they originated as a result of hyperplasia of the chorionic villi. Finally among the many authors linking their origin to aberrations or disturbances of the maternal and fetal circulation such as stasis, increased tension, obstruction, hyperemia singly or in combinations, are Dienst, van der Feltz, Johnstone, Schindler, J. P. Maxwell, McDonald and Burnett, and Pitha.

Today the origin and formation of chorio-angiomas are explained in the following generally accepted manner. A group of blood vessels and stroma are thought to take on active proliferation and growth outside of the regular arrangement and restriction of the normally developing chorionic villi. Without the guidance of the chorionic epithelium covering the villi, the tumor forms in the chorionic surface plate or in some cases in the large trunk villi and develops independently of the normally developed surrounding tissue. Thus the tumor with its capsule is somewhat isolated and does not bear a physiological relation to the functioning portions of the placenta. Its growth is not limited.

Whether the anlage is congenital or whether it is a faulty tissue mixture depends upon whether one believes with Ribbert that it is a

true tumor, or with Albrecht and R. Meyer that it is a malformation or *hamartoma*.

#### TYPES

Fuller consideration of the histological structure of chorio-angioma, as described under the pathological anatomy, reveals that the tumor may be differentiated into various types. However, such a differentiation does not carry the implication that these forms may be classified as different tumors. They represent various phases of development in different or in the same chorio-angioma. Furthermore, this attitude lends understanding to the discussion of tumors which at first were misunderstood and were ultimately proven to be chorio-angiomas as well as to other conditions which have been incorrectly diagnosed as this tumor.

In the first place we should consider the cellular, more immature, or less differentiated type. Again may we refer to Beaufays' *angioma mesenchymale* of the placenta which we believe is a chorio-angioma with less differentiated manifestations of the more adult tumor and consequently of the same origin. This cellular type is the one that has been frequently and incorrectly designated in the past as sarcoma, fibrosarcoma, and angiosarcoma of the placenta. As yet a chorio-angioma with proven malignant changes remains to be reported. Cary's case of sarcoma of the placenta, examined and thought to be sarcoma by J. W. Williams and Welch, was later reconsidered by Williams and shown to be a chorio-angioma. However, malignant metastases to the placenta have been described on 3 occasions (the cases of Walz, Senge, and Markus). Lacassagne and Vignes have pointed out that the degree of proliferation of the endothelium makes one think of endothelioma. Frayman and Gorjajewa in 1928 reported a case of endothelioma placenta. The illustrations of this tumor convince us that in all likelihood it is a chorio-angioma of the cellular type. Because of its occasionally compact structure, this type has also been incorrectly diagnosed as fibroma of the placenta (Auvard, Kramer). On the other hand, there have been tumors designated as fibroma of the placenta which were later thought to be, and in one or two instances proved to be, submucous myoma of the uterus.

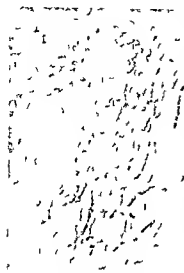


Fig 13

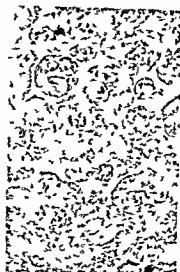


Fig 14

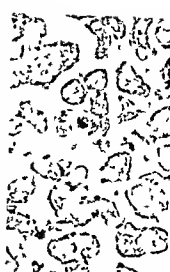


Fig 15

Fig 13 Case 6 The degenerated type of chorionic angioma having an areolar and myxomatous appearance  $\times 120$

Fig 14 An area from a placenta illustrating the condi-

tion designated as angiecta is of the chorionic villi but often mistaken for chorionic angioma  $\times 120$

Fig 15 An area of a normal placenta inserted for contrast and comparison  $\times 240$

the mesenchymal angioma. In the same paper he quotes Klinge's conception of the histogenesis of angiomas to give support to his argument. However, as he concludes that the mesenchymal angioma is a different tumor from the simple placental angioma because it has a different origin, we must beg to arrive at a different conclusion. By simple placental angioma we interpret him as meaning chorionic angioma. If our interpretation is correct the tumor he describes has the same origin as the chorionic angioma and we consider it merely a manifestation of the immature cellular type.

The hypothesis that chorionic angiomas may represent phases in the development of the hydatidiform mole or chorio epithelioma as pointed out by Virchow, Valeri and Storch is now considered wholly untenable. The mole and chorio epithelioma are tumors of epithelial origin and pre eminently associated with malignancy, 2 characteristics which contrast decidedly and unquestionably exclude any relationship to chorionic angioma.

#### ORIGIN

It is desirable to introduce the subject of the origin of chorionic angioma with a brief discus-

sion of whether an angioma is a true tumor or not. Indeed, this is a controversial point among pathologists which still remains unsettled. There are 2 prevailing points of view. The first, and one which seems to be accepted generally, is Ribbert's idea that it is an independent growth originating from a rudiment predetermined to form blood vessels. The second is the conception championed by Albrecht and supported prominently by R. Meyer, that angiomas are the result of fetal displacement or malformation of tissue. Albrecht differentiates these displacements and perverted formations as *hamartomas* and when they assume the form of a tumor R. Meyer distinguishes them as *hamartoblastomas*. Hinselmann enjoys a little play in antithesis when he calls chorionic angioma the antipode of hydatidiform mole. The former is a malformation caused by an excess of development or *Excessmissbildung* whereas the latter is a malformation resulting from arrest of development or *Hemmungsmissbildung*.

The unchallenged conception and definition of a tumor is still to be sought and further discussion of this subject is left to the investigator with more profound philosophic and aca-

or fetus was certainly not affected by the presence of a chorio-angioma. Among them, it is true, there was an infant considered premature, but she was born of a mother with a toxemia of pregnancy, a complication that is known to affect the size of a baby in many instances. In these cases also, hydramnios and premature rupture of the membranes were not noted in a single instance. With the possible exception of hydramnios and the extremely rare possibility of dystocia, it may be concluded from the evidence we have at hand that chorio-angioma is clinically insignificant.

# CASE REPORTS

Six of the following 8 cases were collected during the last 5 years; the 2 others were found in the older material preserved in our pathological museum.

**CASE 1** B R, (Berwind No 32551, P-223), white, secundipara, age 22. The last menstrual period occurred on March 2, 1932, expected date of confinement was December 9, 1932. There was a normal antenatal course, and a spontaneous delivery without a history of premature rupture of the membranes of a normal, female, living infant weighing 4,060 grams on December 3, 1932. Duration of labor was 3 hours and 10 minutes, blood loss 150 cubic centimeters, puerperium was normal.

**Placenta** The placenta weighed 775 grams and was 2 by 16 by 17 centimeters in size. On the maternal surface and extending into the substance of the placenta, a fibrous, well circumscribed nodule measuring 2.5 by 4 by 4 centimeters was found. The tumor was readily enucleated from its bed and on bisection the cut surface was grayish-red in color. Microscopic examination revealed a well encapsulated chorio-angioma of the cellular variety. For the most part the texture of the tumor appeared compact. Here and there, along the periphery especially, one saw isolated angiomatous areas. The denser areas, which made up the greater part of the tumor, conformed to the immature type of tumor described in the text, that is, collapsed capillaries and interstices lined with endothelial cells supported in a network of connective tissue and stromal cells of a more embryonal character. Occasionally a cell was observed in mitotic division.

**CASE 2** E S, (No 22433, P-510), white, nullipara, age 30. The patient's last menstrual period occurred on August 15, 1932, expected date of confinement was May 22, 1933. There was a normal antenatal course with no history of premature rupture of the membranes. Spontaneous delivery of a normal, female, living infant weighing 2,850 grams, June 2, 1933. Duration of labor, 7 hours 9 minutes, blood loss, 300 cubic centimeters, puerperium, normal.

**Placenta** The placenta weighed 720 grams, the dimensions were 4 by 8 by 10 centimeters. A small, firm, rounded tumor measuring 3 centimeters in diameter was found just beneath the amnion on the fetal surface halfway between the centrally inserted umbilical cord and the margin of the placenta. Microscopic study showed that it was a well preserved chorio-angioma of the vascular type. Uniformly it consisted of dilated capillaries filled with red blood cells. The stroma was composed of ovoid cells which were found scattered in small numbers in the connective tissue spaces between the capillaries. Inasmuch as compact cellular areas or degenerated ones were entirely absent in this tumor, it can be considered an example of the mature variety of chorio-angioma.

**CASE 3** M T, (No 44808, P-738), white, quintipara, age 30. The patient had her last menstrual period on February 1, 1933, expected date of confinement was November 8, 1933. The antenatal course was complicated by hypertension and chronic nephritis. On November 8, 1933, spontaneous delivery occurred of a normal, female, living infant weighing 3,300 grams. Duration of labor was 1 hour and 50 minutes, blood loss was 200 cubic centimeters. The patient was discharged in good condition.

**Placenta** The weight of the placenta was 420 grams, the dimensions, 2 by 15.5 by 17 centimeters. Buried in the substance of the placenta, at the time that it was examined and sectioned, a small firm nodule 1.5 by 2.5 centimeters was found. The small tumor was readily enucleated from the surrounding placental tissue and its consistency was noted to be just a little firmer than the placenta itself. Microscopic examination disclosed that it was a chorio-angioma of the degenerated type. In general one finds vacuolated areas resembling areolar or myxomatous tissue. The capillaries have lost their endothelial lining, wholly or in part, and for the most part the red blood cells have disappeared from the lumina of the vessels. Here and there one does find areas in a better state of preservation making its recognition as a chorio-angioma unmistakable.

**CASE 4** E R, (No 107080, P-1605), white, nullipara, age 24. The last menstrual period occurred on December 28, 1934, expected date of confinement was October 5, 1935. Antenatal course was normal. On September 26, 1935, there was a low forceps delivery, because of a prolonged second stage, of a normal, male, living infant weighing 3,220 grams. Duration of labor was 9 hours and 6 minutes, blood loss 400 cubic centimeters, puerperium was normal.

**Placenta** The weight of the placenta was 850 grams, the dimensions 2 by 19 by 19 centimeters. A tumor 5 by 6 by 6 centimeters was found on the margin of the fetal surface. Microscopic study showed that it was a chorio-angioma of the vascular variety. This one is not found as entirely typical as the tumor described in Case 2. There are a few regions showing transition from the cellular structure to the angiomatous one. However, considered as a whole the pattern conformed to the more mature or vascular chorio-angioma.



(Harper, Hodgen, Loeb) It is quite conceivable that a submucous myoma can be overlapped by a placenta and form vascular connections with it. At the completion of delivery the myoma may detach itself with the placenta or it may be removed manually because of postpartum hemorrhage, an experience which we have already encountered in this clinic. Gheorghiu's and Hoyack's cases also, were probable instances of submucous myomas and not placental fibromas.

The full grown angiomatous tumor should in our opinion be regarded as the vascular or mature chorio angioma. This is the type that has been least mistaken even though it has had its share of diverse designations. At this point, it would be well to discuss and direct attention to a condition which may be commonly seen in placental villi. This is not a tumor formation but has been incorrectly diagnosed chorio angioma. Occasionally in the intraplacental substance one finds circumscribed or diffuse areas of agglutinated villi. These fused villi show some edema of the stroma, partial or total loss of their surface epithelium and above all dilatation of the individual blood vessels (Fig 14). G. Mueller classifies it as a pseudo angiomatous structure and in our opinion correctly designates it as angiectasis of the chorionic villi. Meyenburg prefers to speak of it as *hamangiomatosis diffusa placenta* or simply *angiomatosis of the placenta*. Schickele terms it an intraplacental angioma resulting from blood vessel proliferation in an already formed villus. The cases reported by Moller and Lohse, Gueniot and Brugger are examples of angiectasis.

Finally, there is the type showing various degrees of degenerative changes. This form with its vacuolated, areola like edematous areas has been frequently interpreted as myomatous. Oskar Frankl objects to the affixation *myomatosis*, and states that this term is incorrect inasmuch as mucus cells do not come into the consideration.

It is obvious that these characteristic types develop in the same or in different chorio angiomas, but we wish to emphasize and are quite confident that they represent various phases of development in the same tumor process.

#### CLINICAL ASPECTS

From the purely clinical point of view it is apparent that chorio angioma has been given more significance in relation to the welfare of the mother and fetus than it merits.

It is important to point out that it is always a benign tumor. Authors in particular Bochi who have emphasized the sarcomatous histological characteristics of the cellular type have in turn indicated the benign nature of the tumor as borne out by the course and follow up of their patients. No relationship has been definitely established between any disease complicating pregnancy and chorio angioma.

The frequent association of hydramnios with this tumor is being recognized as more accidental than actual. Formerly more emphasis was placed upon chorio angioma and hydramnios with its consequent morbid relationship to the fetus, prematurity, stillbirth, malformations, etc. Theveny intimates that this correlation is purely coincidental. Schickel, discussing Thomas' case in 1905 could not definitely link the 2 conditions. More recently Kuehnelt in his critical, statistical study, although leaving the question open, tended to present evidence in favor of it being coincidental. However Szarthy reports a hydramnios incidence of 31 per cent in his review of the literature, a figure which is impressively high and would seem to connote an interrelationship between the tumors and excessive amniotic fluid.

One complication, though rare, which may arise is the possibility of a large chorio angioma being so situated that it may cause an obstruction to the normal birth of the fetus. Emge and Margeson have each reported a case in which cesarean section was performed for dystocia, later finding that the circumstance mentioned above was the provocative cause.

Chorio angiomas have been considered to have a deleterious effect upon the fetus. From the studies of Siddall, Kuehnelt and others, closer evaluation of their statistics seem to indicate that the high incidences of prematurity, stillbirths, and premature rupture of the membrane are attributable to other more significant causes and complications. In our small series of 8 cases the welfare of the mother

- 15 Ibid Monatschr f Geburtsh u Gynaek, 1906, 23: 527
- 16 ENGEL, L A Am J Obst & Gynec, 1927, 14: 35
- 17 FELTZ, G W, VAN DER Monatschr f Geburtsh u Gynaek, 1900, 11: 770
- 18 FRANKL, O Liepmann Handb d Frauenheilk, 1914, 2: 134
- 19 FRAYMAN and GORJAJEWA Monatschr f Geburtsh u Gynaek, 1928, 78: 185
- 20 GHEORGHIU Bull et mém Soc de chir de Bucarest, 1904-1907, 7-8: 16
- 21 GOODHART, J F Tr Obst Soc London, 1877, 19: 256
- 22 GRAFENBERG, E Ztschr f Geburtsh u Gynaek, 1908, 63: 537
- 23 GUENOT Bull et mém Soc obst et gynéc de Par, 1915, 4: 1
- 24 HARPER, R Lancet, 1852, 1: 306
- 25 HILDEBRAND, H Monatschr f Geburtsh u Gynaek, 1868, 31: 346
- 26 HINSELMANN, H Halban-Seitz, Biologie und Pathologie des Weibes, 1925, 6: 309
- 27 HODGEN, J T Brit M J, 1879, 2: 370
- 28 HOJNACKI Monatschr f Geburtsh u Gynaek, 1902, 16: 934
- 29 JOHNSTONE, R W J Obst. & Gynaec Brit Emp, 1923, 30: 262
- 30 Idem Brit M J, 1912, 2: 1113
- 31 KLINGE, F Deutsche Zentralbl Chir, 1923, 183: 195
- 32 KRAMER Ztschr f Geburtsh u Gynaek, 1890, 18: 335
- 33 KUEHNEL, P Acta obst & gynéc Scand, 1933, 13: 143
- 34 LACASSAGNE and VIGNES Bull. Soc d'obst et gynéc de Par, 1921, 10: 208
- 35 LEOPOLD Zentralbl f Gynaek, 1895, 19: 922
- 36 LE PAGE, M G Bull Soc d'obst et gynéc de Par, 1913, 2: 666
- 37 LOEBL Ztschr der k k Gesell der Aerzte zu Wien, 1844
- 38 LONNBERG, I Hygiea, Stockholm, 1898, 60: 211
- 39 MAPCESON, R D Boston M & S J, 1920, 182: 200
- 40 MARKUS, N Arch f Gynaek, 1910, 92: 659
- 41 MARS, A R von Monatschr f Geburtsh u Gynaek, 1896, 4: 229
- 42 MAXWELL, J P China M J, 1925, 39: 1086
- 43 MAXWELL, R D Proc Roy Soc Med. Obst Sec, 1911-1912, 5 (part 2): 149
- 44 McDONALD and BURNETT J Path & Bacteriol, 1912-13, 17: 112
- 45 MERTTENS, J Ztschr f Geburtsh u Gynaek, 1894-95, 31: 60
- 46 MEYENBURG Ziegler's Beitr z path Anat u z allg Path, Jena, 1922, 70: 510
- 47 MEYER, R Ztschr f Geburtsh u Gynaek, 1923, 86: 419
- 48 Idem Zentralbl f Gynaek, 1923, 47: 157
- 49 MOLLER and LOHSE Ugeskr f Læger, 1919, 81: 1110
- 50 MUELLEP, G Casop česk, lékařů, v Praze, 1907, 46: 927
- 51 PITHA, W Wien klin Rundschau, 1907, 21: 441, 460
- 52 PLAUCHU and SAVA Arch mens d'obst et de gynéc, 1913, 3: 247
- 53 RIBBEPT, H Ztschr f Geburtsh u. Gynaek, 1915, 77: 205
- 54 RIES, E Am J Obst, 1904, 50: 84
- 55 SCHICKLELE, G Beitr z Geburtsh u Gynaek, 1905, 9: 481
- 56 Idem Deutsche Ges f Gynaek, 1909, 13: 486
- 57 Idem Gynéc et obst, 1924, 9: 50
- 58 SCHINDLER, R Arch f Gynaek, 1908, 84: 423
- 59 SENGE Beitr path anat, 1912, 53: 536
- 60 SIDDALL, R S Am J Obst & Gynec, 1924, 8: 430
- 61 Idem Johns Hopkins Hosp Bull, 1926, 38: 355
- 62 SOLOWITJ, A Monatschr f Geburtsh u Gynaek, 1902, 16: 719
- 63 STORCH, E D Arch f path Anat, 1878, 72: 582
- 64 SZARTHUARY, Z Arch f Gynaek, 1934, 155: 453
- 65 THEUVEVEY Rev mens de gynéc, d'obstét et de pédiat, 1910, 5: 7
- 66 VALERI, R M Ann d'ostet, 1915, 37: 131
- 67 VINCOW, R Die krankhaften Geschwulste Berlin 1863, 1: 415
- 68 WALZ Verhandl d deutsch path Gesellsch, 1906, p 270

**CASE 5** J. C. (Berwind No 40891 P 2956) white septipara age 32 The patient's last menstrual period took place on March 6 1937 expected date of confinement was December 13 1937 The antenatal course was normal Spontaneous delivery of a normal female living infant weighing 3500 grams occurred on December 10 1937 There was no history of a premature rupture of the membranes Duration of labor was 3 hours and 42 minutes blood loss 175 cubic centimeters and the puerperium was normal

**Placenta** The weight of the placenta was 700 grams the dimensions 3 by 23 by 29 centimeters Protruding from the margin of the maternal surface was a tumor measuring 3 by 3 by 4 centimeters Microscopic examination revealed that the tumor was a chorio angioma of the cellular variety The histological picture was similar to the one described in Case 1 except that there were fewer angiomatous changes in Case 5

**CASE 6** A. S. (No 194682 P 3125) white, primipara age 37 The last menstrual period occurred on July 11 1937 expected date of confinement was April 18 1938 The antenatal course was complicated by a toxemia chronic nephritis The membranes ruptured at the onset of labor and there was a low forceps delivery of a normal premature female living infant weighing 2230 grams and whose length measured 40 centimeters Delivery occurred on March 29 1938 Duration of labor was 5 hours and 47 minutes blood loss 80 cubic centimeters The patient was discharged in good condition as was also the baby

**Placenta** The placenta weighed 600 grams and measured 3 by 16 by 18 centimeters About 4 centimeters away from the insertion of the cord on the fetal surface just beneath the amnion a small tumor 1 by 1 centimeters was enucleated Microscopic study demonstrated a chorio angioma of the degenerated type This tumor was not unlike the one described in Case 3

**CASE 7** E. H. (No 82873 I 3093) white primipara age 34 The last menstrual period was on January 4 1930 expected date of confinement was October 11 1930 The antenatal course was complicated by an unclassified toxemia On October 9 1930 a mid forceps delivery of a normal female living infant weighing 2400 grams and 40 centimeters long was performed Duration of labor was 65 hours and 30 minutes without a history of premature rupture of the membranes blood loss 400 cubic centimeters puerperium was normal

**Placenta** The weight of the placenta was 530 grams the dimensions 17 by 17 by 19 centimeters Close to the insertion of the cord on the fetal surface a tumor was found measuring 2 by 3 by 3 centimeters Microscopic examination showed that it was a chorio-angioma of the immature type It conformed in structure and pattern to the cellular variety described in the text

**CASE 8** (P 3004) The clinical history of this patient could not be found However the specimen

was preserved in our museum and a photograph of it is reproduced in the text (Fig 1) In its fixed condition the placenta weighed 700 grams and measured 4.5 by 8 by 10 centimeters Microscopic study disclosed that it was a chorio angioma of the vascular type

#### SUMMARY

- 1 Benign tumors of the placenta designated as chorio angiomas are relatively rare
- 2 On the basis of their histological structure and pattern these tumors are differentiated into several types The cellular or immature, the vascular or more mature type, and that type accompanied by varying degrees of degenerative changes are presented These forms may intermingle in all gradations in the same tumor
- 3 The histogenesis of these tumors is fairly well established The tissue originates from the chorionic mesenchyme the proliferating endothelium and blood vessels playing the leading rôle, the stroma a subordinate or accessory rôle
- 4 Whether the neoplasm is a true tumor according to Ribbert a idea or a malformation as explained by R. Meyer is still an open question
- 5 The older discarded theories of the origin of the tumors and that which has been accepted are discussed
- 6 Clinically it is believed that chorio angiomas are of little significance
- 7 Two hundred and nine cases are collected from the literature, to which are added 8 of our own bringing the total number to 217

#### REFERENCES

- 1 ALBERT W. Arch f Gynaek 1898 56 144
- 2 ALBRECHT H. Frankfurt Ztschr f Path 1901 158
- 3 ALLARD A. Bull et mém Soc obsi et gynéc de Par 1897 3 261
- 4 BEACREYS J. Arch f Gynaek 1910 162 14
- 5 Ibid 1937 164 646
- 6 BEYER R. Verhandl d deutsch path Gesellsch 1900 2 407
- 7 BERGLUND A. Acta gynec Scand 1914 3 117
- 8 BOETT P. Arch f Gynaek 1915 104 235
- 9 BREUER Schweiz Rundschau f Med 1922 22 49
- 10 CARY W. H. Am J Obst 1914 69 655
- 11 CLARKE J. Te Phil Soc London 1798 p 361
- 12 DANYAL Cas méd de Par 1844 p 372
- 13 DIENST A. Ztschr f Geburtsh u Gynaek 1903 45 191
- 14 Idem Monatschr f Geburtsh u Gynaek 1904 20 1052

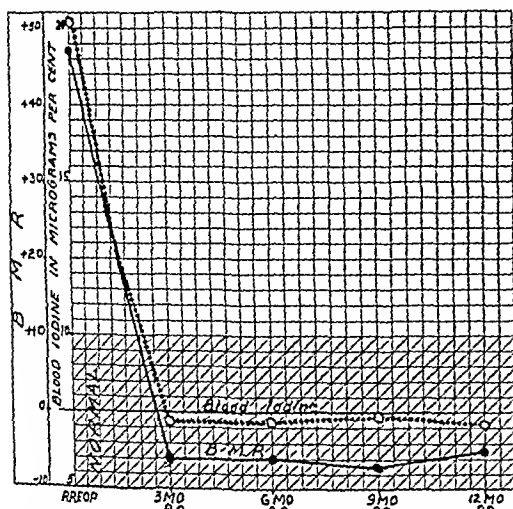


Fig 1 The relation of the blood iodine level to the basal metabolic rate before and after subtotal thyroidectomy in cases of Group I

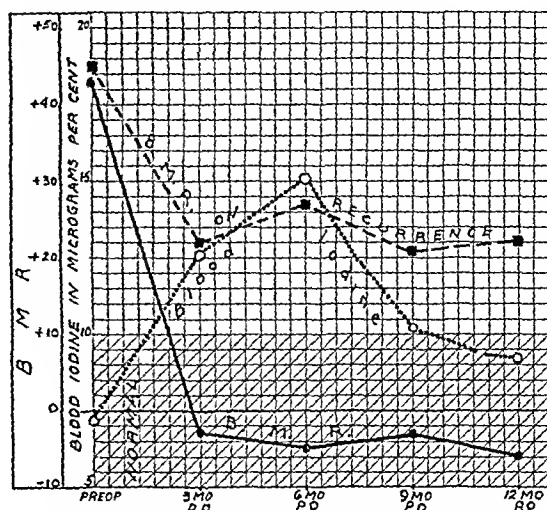


Fig 2 The relation of the blood iodine level to the basal metabolic rate before and after subtotal thyroidectomy in cases of Group II

the pre-operative and at each postoperative period. The average of the basal metabolic tests on these patients has been included. The findings are shown in Table I. From Table I it will be seen that the blood iodine level paralleled the basal metabolic rate in that the pre-operative elevation in both instances fell to normal values following subtotal thyroidectomy, as shown graphically in Figure 1.

The clinical records of the cases of Group I were noteworthy. Of the 170 cases followed, 154 patients (90.6 per cent) were completely relieved, 15 patients (8.8 per cent) showed transitory postoperative myxedema, 1 patient (0.6 per cent) had recurrent hyperthyroidism.

**Group II** Of 61 cases with a normal pre-operative and a postoperative increase in blood iodine, 28 were followed for 1 year. In the majority of instances, the maximal elevation

in the level of iodine in the blood occurred at the sixth month following operation. The average blood iodine values together with the average basal metabolic rates are shown in Table II. From Table II, it will be seen that no apparent relationship existed between the blood iodine level and the basal metabolic rate. The results are shown graphically in Figure 2.

Analysis of the clinical histories of the cases of Group II revealed that of the 61 patients followed, 45 (73.7 per cent) were clinically cured, 2 (3.3 per cent) had transitory postoperative myxedema, 12 (19.7 per cent) had persistence or recurrence, and 2 (3.3 per cent) had malignant exophthalmos without symptoms of hyperthyroidism.

The high incidence of recurrent hyperthyroidism in patients with a normal or low pre-operative level of iodine in the blood con-

TABLE I —THE PRE-OPERATIVE AND POST-OPERATIVE FINDINGS IN GROUP I

	Cases	Average B.M.R.	Average blood iodine in $\mu\text{gm \%}$
Pre-operative	170	+47	20.1
Postoperative			
3 mos	123	-6	6.9
6 mos	118	-6	6.7
9 mos	56	-7	7.2
1 yr	59	-5	6.8

TABLE II —THE PRE-OPERATIVE AND POST-OPERATIVE FINDINGS IN GROUP II

	Cases	Average B.M.R. Patients (12) with recurrence	Patients cured	Average blood iodine in $\mu\text{gm \%}$
Pre-operative	61	+45	+43	7.1
Postoperative				
3 mos	51	+22	-3	13.1
6 mos	45	+27	-5	15.6
9 mos	31	+21	-3	10.4
1 yr	28	+22	-6	8.2

$\mu\text{gm}$  —microgram

# BLOOD IODINE LEVELS RELATED TO THE RECURRENCE OF HYPERTHYROIDISM

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**A**BETTER understanding of the metabolism of iodine in patients with goiter has been realized by the quantitative analysis of iodine in the blood. Many investigators (1, 2, 3, 4, 11) have repeatedly demonstrated the presence of abnormal blood iodine levels in cases of hyperthyroidism. In previous reports, we have shown that the estimation of the pre-operative level of blood iodine has been an aid not only in establishing the clinical diagnosis (5) but also in evaluating the severity of the disease (6). Two reports (1, 9), dealing with the blood iodine level at intervals after operation, have appeared in the literature. In this connection our previous work (9) indicated that, following subtotal thyroidectomy, estimations of the level of iodine in the blood taken at stated intervals have given us a means whereby cases can be predicted which are predisposed to recurrence or persistence of clinical hyperthyroidism. The present report consists of further observations on the level of iodine in the blood before and after subtotal thyroidectomy for hyperthyroidism. Furthermore we wish to present additional evidence from the present results, which permits a selection of patients in whom recurrence is likely to follow subtotal thyroidectomy. It is our belief that more radical operations in these cases will result in a lower incidence of recurrent hyperthyroidism.

The study is based on 256 cases of exophthalmic goiter with 833 blood iodine values of these patients. This comprises an additional group to those previously reported (9). In so far as could be determined none of the patients had received any treatment for their hyperthyroidism prior to coming under observation at The Lahey Clinic. The blood iodine level was determined in each case before beginning the administration of Lugol's

solution (7, 8). All the patients were examined at intervals following operation at which time the amount of iodine in the blood was again estimated. Of the 256 patients 100 returned at intervals during 1 year for these check up examinations. During the course of this study, while observing these 256 patients approximately 750 additional cases were studied by the same methods and criteria. This larger group was excluded from the present report because of positive or presumptive evidence from either the patient or referring physician that iodine medication had been received prior to coming under our observation. It is probable that a few of these cases not included in this report should not have been excluded.

In a previous report (9), the findings showed that patients with hyperthyroidism with a pre-operative elevation in blood iodine have normal levels following subtotal thyroidectomy (designated as Group I below). On the other hand we found that individuals with signs and symptoms of hyperthyroidism in the presence of a normal blood iodine, had a relative increase in the blood iodine level after operation (Group II). The additional findings to be presented in this paper confirmed the above observations. In addition a group of cases has been encountered in which the pre-operative blood iodine value was found to be normal with no change in this level following subtotal thyroidectomy (designated as Group III). Since all of our cases with hyperthyroidism studied fall into one of the above groups, we have divided them into the 3 groups mentioned: Groups I, II and III.

**Group I.** Of 170 patients with hyperthyroidism with an elevated pre-operative blood iodine level who were examined after operation at regular intervals 59 were followed for 1 year. Since the results of the group as a whole were relatively consistent it is considered fair to average the blood iodine values at

increase in the duration of symptoms, reaching a maximum at the 4 to 5 year duration period

Our present conception of the clinical aspects of exophthalmic goiter permits certain correlations with the results of study of the pre-operative and postoperative blood iodine levels. Clinical experience attests to the view that certain features of thyrotoxicosis differentiate those individuals with acute recent onset and those who have been suffering from the disease for a considerable period of time. In this connection, the present results suggest that there may be an actual hypersecretion of iodine from the thyroid gland during the earlier stages of the disease. Such an interpretation, however, is only reasonable if the blood iodine level is influenced by excessive thyroid secretion. Should this hypothesis be adopted, it follows that subtotal thyroidectomy would remove the source of the excessive secretion with symptomatic relief. The elevated pre-operative and normal postoperative blood iodine levels of the cases of Group I lend credence to such a view.

The above hypothesis, however, does not appear to hold for the majority of individuals who have had untreated hyperthyroidism for 1 year. In these cases the pre-operative blood iodine level was generally found to be normal (10). That hypersecretion of iodine products from the thyroid gland could account for the symptoms of thyrotoxicosis seems doubtful. This becomes still more confusing when it is noted that, following surgical treatment, the blood iodine level usually increased to approximately twice the normal level (cases of Group II). Although 19.7 per cent of patients showing such a phenomenon had recurrence or persistence of hyperthyroidism, 73.7 per cent of the patients having similar blood iodine levels were considered to be clinically cured. At least in this group of cases (Group II) it is difficult to conceive that excessive thyroid secretion was a primary factor.

Furthermore, it would appear that, if the symptoms of clinical hyperthyroidism were allowed to persist untreated from 4 to 5 years, the blood iodine level is not only normal, but in most cases uninfluenced by subtotal thyroidectomy. The interpretation for these cases

(Group III) would appear to be that the iodine metabolism, as reflected by the blood iodine level, is a secondary factor in very long standing cases of untreated hyperthyroidism.

The pre-operative level of iodine in the blood of patients with untreated hyperthyroidism can be used as an index of the amount of thyroid gland to be excised. We have correlated the postoperative results with the pre-operative blood iodine levels. Following operation, patients obtain complete relief or have recurrence or myxedema. In cases of Group I with an elevation of the pre-operative iodine in the blood, the unsatisfactory results are primarily due to myxedema, whereas the recurrence rate is very low. A less radical operation is indicated in this group of cases. The unsatisfactory results in Group II, with a normal pre-operative blood iodine level, are chiefly from recurrence, myxedema is rare in this group. The results in cases of Group III in which the pre-operative blood iodine is again normal, are very satisfactory. Since the pre-operative blood iodine is normal in both Group II and Group III, in order to decrease the recurrence rate of cases of Group II it becomes necessary to do a more radical subtotal thyroidectomy in all of the cases in both groups. This seems justified since there is a very low incidence of postoperative myxedema in both Groups II and III. These cases represent only 33.6 per cent of the total but all of the recurrences are found in these 2 groups. In view of the fact that it does no apparent harm and offers a definite opportunity for decreasing the number of recurrences, we strongly urge a radical subtotal thyroidectomy in all cases of hyperthyroidism in which the blood iodine level is normal pre-operatively.

#### SUMMARY

- 1 The pre-operative and postoperative blood iodine levels are reported for 256 cases of exophthalmic goiter, 100 of these patients were followed for 1 year.

- 2 Patients with hyperthyroidism having an elevated pre-operative blood iodine level showed a normal blood iodine level following subtotal thyroidectomy. The incidence of such cases decreased with an increase in the duration of symptoms before treatment.

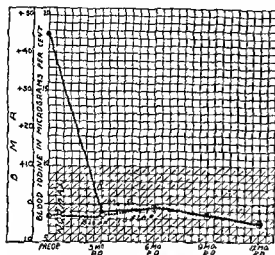


Fig. 3. The relation of the blood iodine level to the basal metabolic rate before and after subtotal thyroidectomy in cases of Group III.

firmed our former observations (9). Further more, there was a consistent increase in the blood iodine after operation in these patients with recurrence of symptoms (Table II). In this group of cases (Group II) myxedema following subtotal thyroidectomy was rare (3.3 per cent). These findings in our opinion justify a more radical thyroidectomy in patients with a normal or low pre-operative blood iodine, in other words relatively smaller thyroid remnants should be left than when the pre-operative blood iodine level is elevated.

**Group III.** There were 25 patients in the group with hyperthyroidism who had a normal blood iodine level before operation and no change in level following subtotal thyroidectomy. Thirteen of these individuals were followed for 1 year. The results of this group are shown in Table III. Table III shows that as in the cases of Group II, there was no obvious

relationship between the basal metabolic rate and the level of iodine in the blood. The results are illustrated graphically in Figure 3. Clinical data of the cases of Group III revealed that of the 25 cases followed 24 patients (96 per cent) were clinically cured and 1 patient (4 per cent) had transitory postoperative myxedema. The hyperthyroid cases of Group III appeared to have the most favorable clinical course following subtotal thyroidectomy of the 3 groups.

Recent studies (10) concerning the relationship between the blood iodine level and the duration of symptoms in individuals with exophthalmic goiter have shown that the blood iodine is usually elevated when the hyperthyroid symptoms have been present for less than 9 months. On the other hand, patients exhibiting untreated symptoms of hyperthyroidism for 1 year or longer usually have blood iodine values within the range of normal. This observation may be correlated with the results of the present study. With the duration of symptoms heretofore established (10) the number of cases in Groups I, II, and III was charted against the duration of symptoms prior to treatment for each case respectively (Table IV).

As will be seen from Table IV: (a) The incidence of hyperthyroid cases with an elevated pre-operative and a postoperative fall in blood iodine (cases of Group I) decreased as the duration of symptoms for the cases increased. (b) The incidence of hyperthyroid cases with a normal pre-operative and a postoperative increase in blood iodine (cases of Group II) increased with a corresponding increase in the duration of symptoms; the greater percentage of such cases occurring at the duration period of 10 to 12 months. (c) The incidence of hyperthyroid cases with a normal pre-operative blood iodine and no change in blood iodine following subtotal thyroidectomy increased (cases of Group III) from 10 to 12 months, with an

TABLE III.—THE PRE-OPERATIVE AND POST-OPERATIVE FINDINGS IN GROUP III

	Cases	Average B.M.R. per cent	Average blood iodine in micrograms per cent
Pre-operative	25	+45	6.6
Postoperative			
3 mos	19	-2	6.8
6 mos	23	-1	7.3
9 mos	21	-3	6.7
1 yr	23	-5	6.4

TABLE IV.—DURATION OF SYMPTOMS

	Group I Cases	Group I Per cent	Group II Cases	Group II Per cent	Group III Cases	Group III Per cent
1 to 4 mos	55	100	0	0	0	0
4 to 7 mos	50	94	3	6	0	0
7 to 9 mos	21	70	9	30	0	0
10 to 12 mos	27	40	31	46	9	14
1 to 3 yrs	24	37	14	37	10	10
4 to 5 yrs	3	53	4	31	6	46

# THE INFLUENCE OF PAPAVERINE ON MUSCULAR TONE OF THE INTESTINAL TRACT

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IT has frequently been demonstrated that morphine sulphate causes an increase in the muscular tone of both the large and small intestine of man and that its administration results in an increase in the frequency and amplitude of the peristaltic waves as well as in the amplitude of the rhythmic contractions. These changes are not prevented by the usual doses of such antispasmodics as atropine.

We previously have suggested the similarity in the state of muscular tone existing in the bowel in cases of the severe toxemia of peritonitis and in cases in which the intestine was affected by morphine sulphate. Regions of contracted bowel, obstructive in nature, alternating with stretches of distended bowel, will be noted. In spite of this, morphine is probably the most commonly used drug for the relief of pain and postoperative discomfort, following gastro-intestinal operations. Likewise, it has long been used as the drug of choice to "splint" or put the bowel at rest in cases of peritonitis. Because of the intestinal hypermotility and obstructive type of contractions that morphine produces we decided to investigate the other alkaloids of opium as well as opium products that are intended to replace morphine or have advantages over the latter drug.

## METHOD OF STUDY

Several patients, who previously had undergone a colostomy because of an intestinal lesion, kindly consented to submit to certain harmless and painless tests in order that they might assist us in this study.

The method of studying these drugs has been described elsewhere (2). It is a well recognized fact that such alkaloids as morphine, codeine, papaverine, narcotine, and thebaine all play parts in the action of opium. Differ-

ent specimens of opium may contain variable amounts of each alkaloid but the average amounts of the various alkaloids found in opium are as follows: morphine, 10 per cent; narcotine, 6 per cent, papaverine, 1 per cent; codeine, 0.5 per cent, thebaine, 0.3 per cent, and narceine, 0.2 per cent. The other alkaloids occur in such small quantities in the crude drug that their action may be considered negligible.

## RESULTS

*Pantopon* Although the other alkaloids may modify the effect of opium, any action of this drug is the result of the comparatively large amount of morphine it contains. The view that opium is a more effective narcotic than morphine has been brought forth from time to time, and one comparatively recent preparation of the alkaloids as they exist in Smyrna opium has been introduced under the trade name of "pantopon." It has not been shown that the narcotic effect of this drug is greater than that of the morphine it contains. It has been said that pantopon has a greater sedative effect on the gastro-intestinal tract than has morphine. If this is true, the effect may be attributable to the papaverine it contains. Our observations suggest that morphine and pantopon act very much alike in increasing muscular tone, peristalsis, and the amplitude of contractions of the intestinal muscle.

*Codeine* The action of codeine on the bowel was less striking than that of morphine, but when codeine was administered in large enough doses the action was essentially the same as that of morphine.

*Papaverine* Allen and MacLean have described the antispasmodic effect of the intravenous administration of papaverine hydrochloride in cases of sudden arterial occlusion. They reported a case in which, after intravenous administration of papaverine, the circulation was re-established. In this case

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3 The majority of patients with hyperthyroidism with symptoms for 1 year had a normal blood iodine level and following subtotal thyroidectomy had an increase in the level of iodine in the blood. The incidence of recurrence in these patients was 19.7 per cent.

4 After symptoms of hyperthyroidism have been present from 4 to 5 years, the blood iodine level was generally normal and usually uninfluenced by subtotal thyroidectomy.

5 Evidence is presented to show that the pre-operative blood iodine level can be used as an index of the amount of thyroid gland to be removed in patients with hyperthyroidism.

6 A radical subtotal thyroidectomy is recommended in all cases of hyperthyroidism with a normal or low pre-operative blood iodine level.

#### BIBLIOGRAPHY

- 1 CURTIS G M and COLE V V The blood iodine in thyroid disease. *Tr Am Ass for Study of Goiter* 1934 p 141
- 2 DODDS E C LAWSON W and ROBERTSON J D

Variations in the iodine content of the blood in hyperthyroidism and non toxic goitre. *Lancet* 1932 223 608-611

- 3 ELMER A W and SCHEPS M Iodine content of blood and of urine and basal metabolic rate their value in diagnosis of function of thyroid gland. *Acta med Scand* 1934 81 126-136
- 4 McCULLAGH E P and McCULLAGH D R Clinical experiences in the use of determinations of blood iodine. *Arch Int Med* 1936 57 1061-1066
- 5 PERKIN H J The value of blood iodine estimation in the diagnosis of hyperthyroidism. *Surg Clin N America* 1935 15 1625-1626
- 6 Idem The value of blood iodine estimations in the treatment of clinical hyperthyroidism. *Surg Clin N America* 1936 16 1509-1511
- 7 Idem Determination of iodine in blood. *Bio-Chem J* 1933 27 1078-1081
- 8 PERKIN H J and CATTELL R B The practicability and significance of blood iodine estimations. *New York State J Med* 1936 36 1033-1034
- 9 PERKIN H J and HORNSTAD L M The blood iodine level before and after subtotal thyroidectomy for hyperthyroidism. *New England J Med* 1936 215 698-700
- 10 PERKIN H J and LANEY F H Relationship between the blood iodine level and the duration of symptoms in 305 cases of exophthalmic goiter. *Arch Int Med* 1938 61 875-879
- 11 TURNER R C Iodine content of certain pathological bloods in a gynecous region. *Proc Soc Exper Biol & Med* 1932, 29 1291-1296



# A STUDY OF THE FLUID AND SODIUM CHLORIDE BALANCE IN PATIENTS TREATED WITH CONTINUOUS SUCTION APPLIED TO INDWELLING DUODENAL TUBES

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**A**LTHOUGH suction applied to an indwelling duodenal tube has, in general, come to be accepted as the method of choice in the management of postoperative distention, occasional disconcerting reports, such as that of Taylor, appear in the literature in which it is alleged that the aspiration of the gastric and duodenal juices has produced serious dechlorination and dehydration. That the possibility of such an occurrence exists unless the fluid and sodium chloride balance is adequately maintained can not be denied. In our experience, however, at the University of Minnesota Hospitals, during the past 6 years no such occurrence has been recognized.

The changed blood chemistry which attends the loss of the upper gastro-intestinal secretions in high mechanical obstruction was first indicated by Hayden and Orr in 1923. In 1926, Walters and Bollman showed that similar changes occurred in dogs with experimental gastric fistulas. Four years later Ellman and Hartman showed that in dogs with complete loss of pancreatic secretion death occurred with characteristic changes in the level of the blood electrolytes. These experimental results have been confirmed by clinical study of patients. The deleterious effects of the loss of fluid *per se* have been studied in considerable detail. The fundamental studies of Gamble on the causes and effects of dehydration have been supplemented recently by the practical investigations of Maddock and Collier. These latter investigators have been concerned with the fluid requirements of surgical patients. Their results have indicated that such patients require more fluid than most clinicians have thought necessary heretofore.

In the light of the above considerations it would seem desirable to determine the extent to which the acid-base and fluid balances of the body are disturbed by the use of suction applied to indwelling duodenal tubes for the removal of gas and fluid from the upper portion of the gastro-intestinal tract. The use of this method of treatment combined with the adequate administration of para-oral fluids gives eminently satisfactory results as far as decompression of the upper gastro-intestinal tract is concerned, but the amount of glucose and saline solutions which should be administered to each individual patient is a question which up to the present time has not been adequately investigated.

## METHOD OF STUDY

This paper is based on the study of the sodium chloride and fluid balances of 19 patients on the surgical service of the University of Minnesota Hospitals.

*Choice of patients for study.* Patients were entirely unselected. All but one were subjected to a major surgical procedure and treated with suction applied to an indwelling duodenal tube during the period of the study. In some cases the studies were begun before operation and carried through the postoperative period for several days. In other cases the studies were begun immediately after operation. Two patients were studied in the relatively remote postoperative period.

*Administration of fluid.* Sixteen patients were allowed to drink as much water as they desired. No other fluid was offered by mouth. In 3 patients no oral fluid was allowed. Para-oral fluid of 3 kinds, normal saline solution, 5 per cent glucose in triple distilled water, and 5 per cent glucose in normal saline solution, was given in variable amounts and combi-

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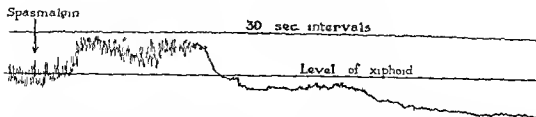


Fig. 1 Effect of 1 cubic centimeter of intravenous administration of papaverine compound (spasmalgin) on the muscular tone of the terminal portion of the ileum: the temporary increase in the tone and motility is the result

of the alkaloid morphine in the spasmalgin; the subsequent decrease in the tone and motility continued for a period of 60 minutes before the normal tonus was gradually resumed.

morphine sulphate as well as intermittent suction and pressure (pavex treatment) had little value in relieving the pain or in re-establishing the circulation. Other writers have reported similar results with papaverine. In our study the intravenous administration of papaverine hydrochloride in doses of 1 to  $1\frac{1}{2}$  grain (0.065 to 0.097 gram), caused a decrease in tone of the intestinal muscle. This was not constant but an increase of tone was not observed when using papaverine in any of our cases studied.

**Papaverine compound.** This drug was introduced commercially under the trade name of spasmalgin; it contains papaverine hydrochloride 0.021 gram, "pantopon" 0.012 gram and "atrinol" 0.001 gram in 1 cubic centimeter of the drug. The addition of the opiate and slower acting antispasmodic atropine has been found to be advantageous in increasing the antispasmodic properties and controlling the pain which usually accompanies visceral spasm. As shown in Figure 1 the comparatively small amount of morphine that spasmalgin contains, although it manifests itself by the temporary increase in tone, is overcome by the papaverine and atropine so that the subsequent and desirable decrease in tone and immobility of the bowel is striking.

Lolling reported the use of spasmalgin in various types of angina and visceral colics, such as those associated with stones in the biliary ducts and ureters. In these conditions pantopon or morphine alone did not produce relief as effectively as did spasmalgin.

#### SUMMARY AND CONCLUSION

It is hardly necessary to call attention to the fact that morphine is one of the most valuable drugs in any physician's practice and we do not presume to supplant it or find a substitute. We would like to call attention, however, to the fact that morphine causes an increase in motility and tone of the large and small intestine of man. It may be that the constipating effect of morphine is attributable to the regions of spasm which it initiates.

The value of papaverine hydrochloride, as such, or in combination with pantopon and atropine should be given serious thought. Clinically, this combination of drugs has been found to have great value in relieving the distressing abdominal cramps and frequent purulent, bloody discharges associated with the acute phase of chronic ulcerative colitis and other acute dysenteries. Experimental evidence has substantiated the antispasmodic effect of this papaverine compound.

Papaverine compound has certain advantages over morphine sulphate in cases in which it is desired to immobilize or put the bowel at rest.

#### REFERENCES

1. ALLEN, E. V. and MACLEAN, A. R. Treatment of sudden arterial occlusion with papaverine hydrochloride: report of case. *Proc. Staff Meet. Mayo Clin.* 1935, 10: 216-220.
2. JACKMAN, R. J. and BARGEN, J. A. The influence of certain antispasmodic drugs on the intestine of man. *Surg. Gynec. & Obst.* 1938, 67: 63-65.
3. LOLLING. Ueber Spasmalgin. *Der Landarzt* 1930, 19: 239.

patient, the diagnosis, the type of operation performed, and the position of the end of the duodenal tube are given. The volume of the urine and aspirated fluid together with the results of the analysis of each are presented. It will be noted that the complete analysis was not made in each case, but the determination of the sodium chloride content was made in practically every instance. With few exceptions the results of blood chemistry studies are given for each day. The two right hand columns of the table show the state of the measurable fluid balance and sodium chloride balance. No account has been taken of the water available from endogenous metabolism, the water lost in the feces, or that lost by vaporization from the skin. As Maddock and Collier have pointed out, these factors must be taken into account in any estimation of the patient's fluid requirements.

It will be noted at once that the amount of fluid aspirated through the duodenal tube varies roughly with the amount of fluid taken by mouth. This is to be expected since most of the fluid swallowed is immediately removed from the stomach by the tube. As the measured quantities of fluid show, however, this relationship is far from exact. Of more importance is the tendency of those patients with a relatively large fluid intake to lose greater amounts of chlorides in the aspirated fluid than do those patients with a more moderate oral fluid intake. Mr W C who was encouraged to drink large amounts of distilled water illustrates this point most clearly. The results in the other patients would indicate that variations in the oral intake of water below 2,000 cubic centimeters for each 24 hours affect the chloride excretion in no characteristic manner. The average patient treated with suction applied to an indwelling duodenal tube loses up to 70 grams of chloride expressed as sodium chloride per day in the aspirated fluid.

The quantitative chemical analysis of the urine revealed no unexpected results. Others have called attention to the failure of the kidneys to eliminate chloride when the blood chloride level is decreased appreciably below the normal level. Patients, Mr D S, Mr W C, Miss R. J, Mr F. S, Mr V S, were all given 1,500 to 3,000 cubic centimeters of 5

per cent glucose in triple distilled water each day for several days. Under these circumstances the daily excretion of chloride by the urine decreased steadily so that in some cases only traces could be detected. Simultaneously with this fall in urinary chloride the level of the plasma chlorides of the blood also fell. It would therefore appear that the chloride content of the urine represents the portion of this element that the body has no use for. Patients treated with suction, as well as other patients who excrete an appreciable amount of chloride in the urine, are receiving an adequate intake of this element and there exists little danger of achlorhydric alkalosis and uremia. As the study of the patients mentioned has shown, however, a good urinary output of over 1,000 cubic centimeters per day may be present despite an inadequate intake of sodium chloride if 5 per cent glucose solution is given para-orally in sufficient amounts.

The results of some of the qualitative tests on the urine specimens were surprising at first sight. Many of the urine specimens gave positive tests for acetone and diacetic acid, even though they contained large amounts of glucose. The formation of these ketone bodies is undoubtedly due to the fact that these patients, with a relative deficiency in carbohydrate, were forced to utilize their body fat to supply their caloric requirements. This phenomenon was noted in patients receiving as much as 3,000 cubic centimeters of 5 per cent glucose solution per day intravenously. None of the patients reported in this paper had diabetes mellitus as shown in the following table.

The importance of a moderately restricted oral and an adequate para-oral intake of fluid in the prevention of an abnormal alteration of blood non-protein nitrogen was indicated by the results obtained in the study of Mrs V S. This patient had had continuous suction applied to an indwelling duodenal tube 14 days preceding the study of his acid-base balance, but had received daily an average of 2,500 cubic centimeters of 5 per cent glucose in normal saline solution intravenously. The non-protein nitrogen of the blood was found to be 37 milligrams per cent on the fourteenth day.

nations to the different patients. In certain cases the fluid administration was so controlled as to provide the optimum conditions for dehydration and alkalosis.

*Aspiration of gastric and duodenal secretions* During the period of study all patients were treated with continuous suction applied to an indwelling duodenal tube. All of these tubes had perforations extending back from the tip some 8 or 9 inches so that even though the tip of the tube extended well into the duodenum, suction would be effectual in both the stomach and duodenum. The position of the tip of the duodenal tube was determined by an x-ray film of the abdomen in each case. Even though in many cases aspiration was confined wholly to the stomach, fluid was apparently removed from both the duodenum and stomach, as attested by its greenish yellow color.

*Collection of urine and aspirated fluid* The urinary output and duodenal tube aspirations were collected for each 24 hour period beginning at 8:30 a.m. All para-oral fluids which in most instances were administered intravenously, were given between 9:00 a.m. and 4:00 p.m. Blood samples for the study of blood chemistry were drawn in the morning before the administration of any para-oral fluid. The urine was preserved by refrigeration and the addition of a small quantity of toluol.

*Analytical methods* An aliquot of the aspirated fluid was filtered by suction through cotton. Free hydrochloric acid was determined by titration to the first transition interval of thymol blue. The total base was determined on 1 cubic centimeter aliquots by the method of Stadie and Ross. The accuracy of this determination was controlled by the analysis of standard potassium chloride solutions containing sucrose.

The specific gravity was determined and the quantitative tests performed on urine by standard procedures. The titratable acidity of urine was determined by the titration of 10 cubic centimeters of urine diluted to 250 cubic centimeters phenol red being used as indicator. The end point of the titration was 7.4 hydrogen ion concentration. A permanent phosphate buffer solution was used for reference. Alkaline urines were titrated to the

same end point with acid and the result reported as acid deficit. Chloride was determined on aspirated fluid, urine, and blood by the method of Cavett and Holdridge. Some difficulty was experienced in the preparation of protein free filtrates of the aspirated fluid by the method of Folin and Wu. In all such cases 5 per cent sulphosalicylic acid was found to remove effectively all protein from this fluid. The quantitative glucose determinations were made by Benedict's titration procedure. The results are reported in grams for total 24 hour samples. Standard procedures were used for the determination of the carbon dioxide combining power of plasma and for whole blood non protein nitrogen analyses.

It was realized that a very significant determination was that of the amount of chloride excretion in the urine, and it seemed desirable to develop a highly simplified and rapid procedure for this determination which could be employed in the routine observation and care of patients. An attempt was made to adapt Purdy's method (8), but in our hands the original method gave inconsistent results. A modification of this method was made where by 10 cubic centimeters of urine were treated in a conical graduated centrifuge tube with 5 cubic centimeters of 6 per cent silver nitrate in 0.03 normal nitric acid. The tube was centrifuged until the volume of precipitate was constant. By this technique 0.1 cubic centimeter volume of precipitate is equivalent to 3.36 milligrams of sodium chloride per 100 cubic centimeters of urine. The results agreed with the titration method within 5 to 10 per cent.

An alternative method and one equally adaptable to clinical use consists in the titration of 5 cubic centimeters of urine diluted to 100 cubic centimeters, with a standard mercuric nitrate solution. Three drops of a 5 per cent sodium nitroprusside solution is used as an indicator and the end point is reached when a permanent turbidity is produced. This method is slightly more accurate than the centrifuge method.

#### RESULTS

The results obtained are presented in the accompanying table. The identification of the

TABLE SHOWING RESULTS—Continued

Fluid output							Blood chemistry			Fluid balance c cm	Sodium chloride balance gm
Urine							Plasma— mg NaCl per 100 c cm	CO <sub>2</sub> combin- ing power— volumes per 100 c cm	Non- protein nitrogen in mg per 100 c cm		
Volume c cm	Specific gravity	Titratable acidity— c cm of n/10 acid per 100 c cm	Grams of sodium chloride	Glucose gm	Acetone	Diacetic acid					
745	1 020	35 35	8 22	o	+	+	643 5	57 5	37 0	+1445	+14 0
440	1 006	30 83	4 17	o	+	+	651 6	55 9	25 0	+120	-7 6
685		Alkaline	5 89	o	+	+	674	50 3		+3515	+31 4
575	1 024	33 75	4 50	o	+	+	616 8	63 8		-785	-10 9
675	1 024	23 70	6 07	o	+	o	650 0	61 0		+2180	+10 6
570	1 026		4 04	o	+	+	661 8	54 0		+3155	+21 5
1120	1 025	Alkaline	9 64	o	+	+	654 8	57 0		+3185	+14 5
870	1 022	9 80	11 47	0 81	+	o	631 9	55 8		+4690	+25 6
715	1 017	16 60	4 61	o	+	+				+3360	+ 2 1
1900	1 007	13 40	5 72	o	+	+				+2100	+ 9 6
3500	1 006	3 77	15 19	o	o	o				-1100	+ 1 2
2030	1 007	3 17	9 30	o	o	o	605 3	61 5		-1770	+ 4 8
360	1 016	11 73	4 75	4 54	+	o	625 5	57 9		+2910	+ 8 6
1830	1 026	-88 64	18 05							+ 40	+14 5
1570	1 017	8 18	14 64	+	o	o	610 0	58 9		+ 980	+ 4
885		-54 28	5 05	+	o	o	572 0	74 0		-1695	-21 7
1200		23 24	6 97	+	o	o	666 5	59 7		+3100	+25 2
1495	1 023		11 48	+	+	+	640 7	59 7		+2000	+13 9
760		Alkaline	7 52	+	+	+	606 4	64 3		+2040	+15 8
1030	1 023	10 75	7 96	+	o	o	618 6	67 8	33 6	- 440	-11 89
250				+	o	o	596 9	66 6		+ 335	
950	1 026	Alkaline	1 63	+	+	o	596 7	67 6	35 8	+ 680	-4 05
1215	1 025	-9 55	3 80	+	o	o	641 1	60 3		+1235	-14 45
950	1 027	9 75	99	+	o	o	606 7	68 7		+2225	- 9 5
760	1 028	32 10	1 55	+	+	o	562 4	68 1	24 1	+ 310	-10 4
940	1 024	22 70	Trace	+	+	o	517 6	82 6	24 8	+2415	- 7 88
1010	1 022	18 30	Trace	+	o	o	566 3	74 0		+2250	+19 4

TABLE SHOWING RESULTS

Identification of patient	Day of test	Position of tip of duodenal tube	Fluid intake					Fluid output			
			Fluid by mouth ccm	Para-oral fluid			Total ccm	Fluid aspirated by duodenal tube			
				5 per cent glucose solution ccm	Normal saline solution ccm	5 per cent glucose in normal saline solution ccm		Volume ccm	Free HCl in ccm of 0.1% acid per 100 ccm	Grams sodium chloride	Total bile equivalents per 100 ccm
Mr. S. D. Age 61 years carcinoma of stomach exploratory laparotomy 15 days before test	1	Stomach	2400		2700	1500	4600	3110	Slightly acid	2.05	45.2
Mrs. M. F. Age 54 years carcinoma of breast radical mastectomy second day of test transfusion reaction	1	Duodenum	1200				1200	840	1.6	3.44	40.5
	1				2000	1700	3700	800	-2.5	1.35	62.5
Mr. J. H. Age 68 years carcinoma of stomach exploratory laparotomy second day of test	2	Stomach	1000				1000	122	37.0	6.40	65.0
	3		1100		2000		3700	975	Acid	4.88	6.5
	3		1200		3000		4200	415	-12.5	1.47	8.0
	4		1700		3000		5100	205	Alkaline	1.03	8.6
Mr. M. S. Age 60 years carcinoma of rectum 1st day of test	1	Stomach		1500	4600		6100	540	3.2	4.20	
	3			3200	1400		5400	1385	5.5	14.85	
	3			2500	2200		4700	900	2.6	6.35	
	3			2300	2400		4700	900	2.2	7.2	
Mrs. F. H. Age 68 years carcinoma of rectum colostomy first day of test	1	Stomach		1500	1800	500	3800	330	1.7	1.86	
Mr. C. K. Age 18 years acute appendicitis 1 day before test	1	Stomach				2000	4000	1170	10.0	4.25	34.5
Mr. A. S. Age 52 years carcinoma of stomach gastric resection 1 day before test		Stomach	1250			2000	350	700	Slightly acid	3.88	116.7
Mr. E. A. Age 50 years tuberculosis of the excretion of tubercle bacilli 1st day of test	1	Stomach	500	500		2000	3000	1810	53.7	23.60	39.8
			500			2500	5150	1050	Acid	8.15	51.0
	4		500			3500	4700	1205	Very acid	6.11	28.7
	4		1000			4500	4000	1100	Acid	8.92	46.6
Mr. D. S. Age 21 years ileitis appendicitis 1st day of test	1	Stomach	600	1000			1600	1000	10	8.93	50.0
			50	8000			101	445	1.0	3.24	2.5
	3		500	2000			2500	87	3.2	43	44.0
	3	Stomach	4000	3000			7000	455	12.7	0.65	11.1
Mr. W. C. Age 53 years ileitis resected on ileal resection	3		1400	1200			6100	1515	15.5	6	32.8
	3		4950	2000			6950	1880	5.1	2.65	20.0
	4		3800	2400			6100	1045	5.5	1.84	31.7
	5		2200	1000		4000	6700	258	1.57	7.80	

TABLE SHOWING RESULTS—Concluded

Fluid output							Blood chemistry			Fluid balance c cm	Sodium chloride balance gm
Urine							Plasma— mg NaCl per 100 c cm	CO <sub>2</sub> combin- ing power— volumes per 100 c cm	Non- protein nitrogen in mg per 100 c cm		
Volume c cm	Specific gravity	Titratable acidity— c cm of n/10 acid per 100 c cm	Grams of sodium chloride	Glucose gm	Acetone	Diacetic acid					
2315	1.013	16.00	3.90	32.10	+	+	597.9	59.7		+1350	+21.9
1655	1.007	10.69	1.69	12.40	+	+	599.7	63.5		+285	-2.8
1790	1.005	4.81	1.28	10.75	+	+	604.6	63.2		+2130	-3.6
1025	1.005	-26.30	.50	3.49	0	0	592.3	59.5		+3215	-3.2
1535	1.020		14.70				588.0	70.0	40.0	+1095	-4.2
2130	1.013		7.60				584.0	70.0	25.0	+560	-12.3
1580	1.014		3.47				564.0			+1400	-6.7
910	1.018		2.54				568.0	69.0	54.0	+3080	-4.4
1080	1.028		2.80				536.0	68.0	54.0	+2100	-6.1
1.00							600.0			+2700	
1200	1.010		4.50				585.0	59.0	43.0		
1685	1.005		6.50				598.0	69.0	32.0	+2345	-8.3
2400	1.010		9.40				566.0			+1520	-14.4
1035	1.006		2.30				559.0	61.0	30.0	+2015	-4.1
2450	1.007		7.30				560.0	60.0	30.0	+1610	-8.2
412	1.020		.87				623.0	71.0	40.0	+545	-1.9
390	1.005		.22				600.0	72.0	36.0	+835	-1.3
740	1.018		.47				556.0	63.0	33.0	+595	-2.7
1050	1.020		.73				546.0	72.0	34.0	+925	-5.3
1465	1.017		11.10				632.0	71.0	38.0	+1635	+1.3
060	1.012		3.30				562.0	57.0	30.0	+2240	-3.5
2210	1.005		3.30				586.0	69.0	30.0	+1405	-4.1
1370	1.007		1.47				536.0	65.0	30.0	+1780	-2.5
660	1.021		2.75				600.0	51.0		+2300	-4.2
1175	1.021		3.60				597.0	59.0	46.0	+1085	+3.9
Incontinent	1.012						546.0	58.0	87.0		
460	1.012		.59				464.0	60.0	80.2	+2040	+9.2
360	1.016		20.30				584.0	67.0	29.0	+2440	
2235	1.022		19.22				490.0	60.0	31.0	-1180	-21.5
1190	1.015		2.10				572.0	71.0	35.0	-950	+4.3
1845	1.011		8.48				612.0	71.0	41.0	-1140	-5.9
920	1.021	-22.56	2.58	0	0	0	538.0	59.8		+80	-3.3
490	1.020	25.62	3.81	0	+	+	657.6	61.6	29.5	+875	+2.3
640	1.025	24.78	5.23	0	+	+	662.4	57.5		-240	-8.3
345	1.030	32.53	1.32	0	+	+	634.1	56.6		-1025	-8.4



TABLE SHOWING RESULTS—Continued

Identification of patient	Day of test	Position of tip of duodenal tube	Fluid intake						Fluid output			
			Fl. id. by mouth c cm	Para-oral fluid				Total c cm	Fluid aspirated by duodenal tube			
				5 per cent glucose in distilled water c cm	Normal saline solution c cm	5 per cent glucose in normal saline solution c cm	Retained blood c cm		1 time c cm	Free HCl in c cm of 0.1% acid per 100 c cm	Grams of sodium chloride	Total no. c milliequivalents per 100 c cm
Miss R. J. Age 32 years acute appendicitis appendectomy second day of test	1	Stomach	1500			5000		4500	1135	3.6	1.13	
	2		800	1500				1300	360	15.3	1.17	
	3		1400	3000				4200	470	34.4	1.47	
	4		2000	3000				3000	760	16.1	1.75	
Mr. J. W. Age 61 years revision of colostomy first day of test	1	Duodenum		2000	1500			3500	310		3.04	
	2		1000	3000				4000	1310		4.70	
	3		800	3000				3600	80		3.15	
	4		1300	3000				4500	310		5.00	
	5		800	3000				3600	5		3.70	
Mr. H. E. Age 70 years carcinoma of the colon colostomy first day of test	1	Duodenum	1200	3000				4200	500			
			400	1500	1500			3400				
	3		1650	2500				4150	42		5.83	
	4		1600	3000				4600	650		8.02	
	5		100	3000				3100	1150		5.70	
	6		1430	3000				4430	300		9.1	
Mr. F. S. Age 3 years repair of inguinal hernia first day of test	1	Stomach	100	1500				600	815		1.7	
			500	3000				1500	1175		1.5	
	3		230	3000				1150	2005		1.80	
	4		500	3000				1500	15.5		4.60	
Mrs. O. E. Age 60 years cholelithiasis cholecystectomy first day of test	5		500	500	500			3500	400		1.00	
	1	Stomach	650	3000				3650	450		3	
	2		700	1000				300	281		8.1	
Mrs. V. S. Age 24 years acute appendicitis with peritonitis	5		450	3000				345	300		67	
	1	Duodenum	00	3000				3100	80		1.50	
	2		200	500	1150			2050	600		1.70	
	3		400	3000				3400	34		7.43	
Mr. A. K. Age 55 years obstruction of colonoplasty laparotomy colostomy first day of test	4		250	1500	2500			3850	75		3.7	
		Duodenum	300	1500	1500			4700	400			
	2		800	1500				3300	13		7.14	
	3		1400	2000	2000			4400	00		00	
Mr. B. G. Age 30 years acute appendicitis appendectomy 3 days before test	4		800	500	000			2300	58		6.35	
		Duodenum	1200					00	00	Slightly acid	70	5.7
Miss P. S. Age 3 years intestinal prolapse appendectomy first day of test	1	Duodenum	1200		3000			2200	835	Acid	1.00	39.5
	2		1000					1600	100	1.3	3.05	11.3
	3		1200					300	450	11.5	7.22	19.0

the urine as by determining the level of the plasma chlorides and with considerable more facility

## BIBLIOGRAPHY

- 1 CAWETT, J W, and HOLDRIDGE, C E New blood plasma chloride method J Lab & Clin M, 1933, 18 944-946
- 2 ELMAN, R, and HARTMANN, A F The cause of death following rapidly the total loss of pancreatic juice Arch Surg, 1930, 20 333-337
- 3 GAMBLE, J L Dehydration New England J Med, 1929, 201 909
- 4 HAYDEN, R L, and ORR, T G. Chemical changes in blood of man after acute intestinal obstruction Surg, Gynec & Obst, 1923, 37 465-468
- 5 MADDOCK, W G, and COLLIER, F A Water balance in surgery J Am M Ass, 1937, 108 106
- 6 STADIE, W C, and ROSS, E C Micro method for determination of base in blood and serum and other biological materials J Biol Chem, 1935, 65 735
- 7 TAYLOR, F W. Nasal tube gastric suction resulting in alkalosis and death J Am M Ass, 1937, 109 267-268
- 8 TODD, J C, and SANFORD, N W Clinical Diagnosis by Laboratory Methods 8th ed Philadelphia W B Saunders Company, 1936
- 9 WALTERS, W, and BOLLMAN, J L Experimental acute gastric fistula Arch Surg, 1926, 13 578-587

In 2 patients, Mr J W, and Mrs V S, the blood non protein nitrogen was definitely elevated. Mr J W was a 65 year old man with mild hypertensive heart disease and Mrs V S was a 24 year old woman with localized peritonitis from a ruptured appendix. Some doubt exists as to the effect of dechlorination incident to gastroduodenal aspiration in causing the slight increase in the non protein nitrogen in the case of Mr J W, but in the case of Mrs V S it is probable that an inadequate intake of sodium chloride was an important factor in the elevation of the blood non-protein nitrogen level. It will be noted that in this case the blood chlorides fell and the carbon dioxide combining power rose.

Most of the patients studied show a carbon dioxide combining power of over 55 volumes per cent. Such values may indicate a mild alkalosis but these can scarcely be attributed to dechlorination, as equally high values are found in those patients with positive chloride balances as in those with negative chloride balances.

A study of the calculated chloride balance, expressed in terms of sodium chloride, shows that no patient who received 2 000 cubic centimeters or more of normal saline solution daily had a negative chloride balance. Furthermore, the negative balances which consistently occurred in those patients given only 5 per cent glucose in distilled water would all have been adequately covered by 2 000 cubic centimeters of normal saline solution. It has been the practice at the University of Minnesota Hospitals for the past 6 years to give patients treated with continuous suction applied to indwelling duodenal tubes between 2 000 and 3 000 cubic centimeters of normal saline solution each day with or without 5 per cent glucose. That such a regimen will consistently prevent dechlorination and alkalosis has been proved both by experience in hundreds of cases and by the results of the studies here reported. It is not meant to convey the impression however that exceptional cases will not occur from time to time in which some variation from this rule will not be indicated. It is our impression that in the usual patient treated with suction to whom inadequate amounts of saline solution are administered several

days must elapse before any real harm is done by the dechlorinating effect of the gastroduodenal aspiration.

#### SUMMARY

The fluid and chloride balances of 19 patients on the surgical service of the University of Minnesota Hospitals treated by continuous suction applied to an indwelling duodenal tube have been studied. Most of these patients were subjected to major surgical procedures and the studies were made in the immediate postoperative period. The duodenal tube aspirations and the urine collected from these patients were subjected to certain quantitative analytical tests. The daily variations in the blood chlorides, carbon dioxide combining power, and non protein nitrogen were followed. The quantity and character of the fluid intake was varied in certain patients. A description of the analytical methods used is given. Two practical clinical methods for the quantitative estimation of chloride in the urine are described.

#### CONCLUSIONS

1 The administration of 2 000 cubic centimeters of normal saline solution daily to the usual patient treated with continuous suction applied to an indwelling duodenal tube will maintain a positive chloride balance and prevent any serious alkalosis.

2 Several days (4 to 5) must elapse before dechlorination incident to the aspiration of the gastroduodenal secretions through an indwelling duodenal tube can do harm to a patient inadequately supplied with sodium chloride.

3 Many patients treated with suction applied to indwelling duodenal tubes will have ketone bodies in the urine despite the daily intravenous administration of 3 000 cubic centimeters of 5 per cent glucose in distilled water or normal saline solution.

4 The patient who excretes daily 3 or more grams of chloride expressed as sodium chloride in the urine is in no danger of achlorhydric alkalosis.

5 The patient's sodium chloride requirements can be as satisfactorily determined by measuring the quantity of chloride present in

developed, the pneumonia was usually secondary to a fulminating pneumococcal peritonitis. There were 6 males and 2 females in this group with a mortality of 62.5 per cent. The third group consists of 16 patients who also had nephrosis as the predisposing cause. There were 11 males and 5 females in this group with a mortality of 68.7 per cent. This is the group in which pneumococcal peritonitis may recur several times, but the children eventually die in childhood due either to the nephrosis or a severe peritonitis. The high mortality from peritonitis in this group may surprise some observers, but the figure seems plausible as only those cases in which the peritonitis was proved by bacteriology or autopsy are included. Even in these cases, there was often a previous history suggesting an attack of pneumococcal peritonitis with recovery.

The age incidence in the cases of pneumococcus peritonitis is evenly distributed between the first and tenth year. This is in contrast to the streptococcus cases, the great majority of which occur between the ages of 6 months and 2 years. Contrary to many reports on pneumococcus peritonitis, which emphasizes the frequency in females, there does not appear to be any significant difference in the sex incidence. In fact in this series, there were more males who had the disease in both the streptococcus and pneumococcus groups, which suggests that the genital organs are not the chief portal of entry.

The clinical manifestations vary according to the severity of the disease. Abdominal pain is the cardinal symptom. It is usually diffuse, but unfortunately from the diagnostic standpoint it sometimes begins in the right lower quadrant. The mode of onset of the pain and its character are difficult to ascertain because of the age of the patient. Other important symptoms are loss of appetite with nausea, and persistent vomiting; fever and diarrhea are also common.

The duration of the symptoms before admission is usually from 1 to 4 days. This does not apply to the group with nephrosis, several of whom developed a respiratory infection while in the hospital and subsequently developed peritonitis. There is a small group of

patients who have been seen 2 to 6 weeks following an attack of abdominal pain with vomiting and fever, and who, on examination, appear emaciated and have a large peritoneal abscess. These large abscesses usually occur in the pelvic region, but sometimes occur in the epigastric region simulating a pancreatic cyst.

Perhaps the most common finding upon physical examination is abdominal distention with tenderness to deep palpation. The degree of muscular rigidity and spasm is unreliable and in several cases the abdomen had been reported as greatly distended but soft with little tenderness. The children usually look sick and dehydrated and in a fulmination case may be in shock. Often an upper respiratory infection is present, as demonstrated in one-fourth of this series, which may predominate the picture and focus all of the attention upon the lungs or ears. Any sudden rise in temperature with abdominal pain and vomiting in children with nephrosis is suggestive of pneumococcus peritonitis. The temperature usually ranges from 101 degrees to 104 degrees and the white blood count is generally higher than one sees in appendicitis, being between 20,000 and 40,000.

In the differential diagnosis appendicitis with peritonitis and a severe upper respiratory infection with abdominal symptoms must be ruled out. In these cases puncture of the abdominal wall with a spinal puncture needle and examination of the peritoneal fluid is of great value, provided a positive result is obtained. This procedure has been described by Neuhoef and Cohen, Danzer, Pollock, and others. The present method of abdominal puncture, as described by Neuhoef and Cohen in 1926 is a simple and safe procedure and is used whenever the necessity arises in the department of pediatrics. Danzer in a recent article stresses the importance of the interpretation of the positive and negative results, and emphasizes that only 1 or 2 drops of pus are necessary for diagnosis if a positive smear is obtained.

*Treatment* There is a marked difference in the mortality figures in the cases of pneumococcus peritonitis in which patients were submitted to surgical drainage as compared to

# PRIMARY STREPTOCOCCUS AND PNEUMOCOCCUS PERITONITIS IN CHILDREN

A Study of 61 Cases with the Report of Two Interesting Recoveries

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THE idiopathic or so called "primary" cases of peritonitis, caused by the Beta streptococcus and the various types of the pneumococcus, while not common in children, occur with greater frequency than is generally recognized. There is considerable variation in the treatment of these cases as can be ascertained readily by reviewing the literature of recent years. Some observers believe in surgical intervention, either early or late, along with medical procedures such as serum etc., while others believe only in supportive measures. The question of the portal of entry remains obscure although the point has been much discussed.

This report reviews the available cases of primary pneumococcus and streptococcus peritonitis from the departments of surgery and pediatrics of the Johns Hopkins Hospital. It includes 2 remarkable recoveries which have occurred this year by newer methods of treatment and which the author has had the opportunity of following carefully. The first was a fulminating case of streptococcus peritonitis in a premature infant which recovered with sulfanilamide therapy. The second was a severe case of pneumococcus peritonitis Type I in which pneumococcus rabbit serum Type I was used with recovery. Both are reported in detail later in this paper. These cases offer hope that the mortality figures which in the literature average from 80 to 100 per cent for streptococcus peritonitis and from 40 to 65 per cent for pneumococcus peritonitis, may be considerably reduced. The incidence of primary peritonitis in children has been variously quoted by European and American authors as between 2 and 10 per cent of the acute abdominal conditions in children. During recent years in the Harnet

Lane Dispensary, 2 to 4 cases of pneumococcus peritonitis and 2 to 3 cases of streptococcus peritonitis are seen each year. The incidence is sufficiently high to warrant special study of this condition.

## ANALYSIS OF CASES

The cases have been derived from the records of the Harnet Lane Home for Children and from the department of surgery covering the past 25 years. There have been 25 cases of primary streptococcus peritonitis and 36 cases of primary pneumococcus peritonitis proved by bacteriological and pathological study. The mortality for the former group is 92 per cent, and for the latter group 61 per cent. Of the total 61 cases, 36 have come to autopsy and have had careful examination of all the organs, both in the gross and microscopically. For the sake of clarity, the 2 groups will be discussed separately and will be further subdivided.

## PNEUMOCOCCUS PERITONITIS

**Clinical.** Most authors divide pneumococcus peritonitis into 2 groups: the severe fulminating cases, and the subacute cases. Some of the patients in the latter group are not seen until the acute symptoms are over and seek admission because of a peritoneal abscess. In the present study a somewhat different classification has been used. The cases of primary pneumococcus peritonitis have been subdivided into 3 groups. The first group is the so called idiopathic group consisting of 12 children. The mortality was 50 per cent in this group, there being 5 males and 7 females. The second group consists of 8 cases in which primary peritonitis was associated with an upper respiratory infection. The upper respiratory infection usually preceded the peritonitis but when pneumonia

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were negative. A diagnosis of appendicitis with peritonitis was made. After intravenous fluids, laparotomy was performed which revealed a generalized peritonitis which was thought to be of gonococcal origin although the fallopian tubes were not greatly inflamed. A normal appendix was removed and the wound closed without drainage. The report of the culture 2 days later from the peritoneal pus was pneumococcus Type I. This was also confirmed on the same day by blood culture. During the interval, the child had declined steadily with frequent vomiting, delirium, temperature 104.6 degrees, and the pulse rate averaging around 170 to 190 despite continuous intravenous therapy. As soon as the cultures were reported, she was transferred to Harriet Lane where, after negative conjunctival and intradermal test doses, a total dose of 295,000 units of anti-pneumococcus rabbit serum was given intravenously at 2 hour intervals over a period of 12 hours. There was rapid improvement, the temperature falling to 99.4 degrees at the end of 24 hours. She received 2 small transfusions of 150 cubic centimeters each on March 2 and March 8, 1938. The only serum reaction was a chill after the first injection and some incontinence 1 week later.

The ultimate recovery of this patient was long and protracted. Twenty-two days later the patient developed a consolidation of the lower lobe of the left lung, which was shown by x-ray. This cleared up but a mechanical intestinal obstruction developed which necessitated an exploratory laparotomy on April 19 and again on April 27 with release of adhesions and evacuation of a small pocket of pus. Culture of this pus was sterile. After this the patient steadily improved and was discharged May 16, 1938, more than 2½ months after admission.

Another interesting case of pneumococcus peritonitis has recently been admitted which is almost identical with the case just reported. The prompt improvement after receiving anti-pneumococcus rabbit serum warrants a preliminary report.

A colored girl, 8 years of age, was admitted on March 27, 1938, acutely ill with signs of generalized peritonitis. She had been sick for 2 days complaining of abdominal pain which began in the right lower quadrant. Vomiting and diarrhea followed 8 hours after the onset of her illness. She had been given castor oil on 2 occasions. At exploratory laparotomy, the appendix was normal but there was a generalized peritonitis from which a smear and culture were taken. Type I pneumococcus was typed from the smear and was later grown from the peritoneal and blood cultures. She received 300,000 units of anti-pneumococcus rabbit serum in the same manner as Case 1 with prompt improvement. Her convalescence was satisfactory until the patient developed a peritoneal abscess which was incised

and drained, pneumococci being cultured from the abscess. After this procedure, the patient improved more rapidly and was discharged on April 20, 1938, 24 days after admission to the hospital.

#### STREPTOCOCCUS PERITONITIS

*Clinical.* These cases have been divided into 2 groups: the idiopathic group and the group associated with erysipelas. In the idiopathic group, there were 17 cases with a mortality of 88.2 per cent. There were 11 males and 6 females. In the erysipelas group the mortality was 100 per cent, there being 8 cases, 4 males and 4 females. Race is apparently of no importance in either the streptococcus or pneumococcus group, the proportion of white to colored children being approximately the same as the general admissions to the hospital.

The age incidence for streptococcus peritonitis differs considerably from the cases of pneumococcus peritonitis, most of these cases occurring in the first 6 months of life (18 of the 25 cases). This is of importance in diagnosis, as appendicitis in children is extremely uncommon before the age of 2 years according to Lipshultz, Lowenburg, Marsch, and others. Marsch's figures for 9,000 cases of appendicitis reveal that only 1.1 per cent occurred between the ages of 1 and 5 years.

The most important symptoms in the cases of streptococcus peritonitis in the order of their frequency are: vomiting, diarrhea, and abdominal pain. Many of these children are too young to reveal pain except by fretfulness and crying, particularly when the abdomen is touched.

The more important signs are an acutely ill, often moribund, child with considerable abdominal distention. The abdomen is tender to palpation but not board-like. In several of the cases the umbilicus and surrounding area for about 2 centimeters were red and swollen. Unfortunately, this is a late sign, which usually is seen in moribund infants. The children may have evidence of a streptococcus infection elsewhere, such as a pharyngitis, a cellulitis of the skin, or an otitis media. Leopold and Kaufman quote Mordlund's series of primary streptococcus peritonitis in which 63 per cent of the cases have a preceding upper respiratory infection.

those who were not. The 15 cases which were drained had a mortality of 26.6 per cent as compared to a mortality of 82.6 per cent in the 23 cases in which surgery was not attempted. However, these statistics need qualification. First it is well accepted that surgical drainage is indicated in those cases in which localization has occurred but in the early acute stages there is considerable disagreement as to the value of drainage. In this series it is suggestive but not conclusive that early operation and drainage are of value. If the cases of nephrosis and all subacute or chronic cases are omitted, 14 similar cases of acute primary peritonitis remain. Of this number, 7 were drained early with a mortality of 42.8 per cent while the 7 which received only the same type of supportive measures had a mortality of 85.7 per cent. No serum was given in either group. The only factor which is not identical in the 2 groups is that of age. The patients treated surgically are slightly older, especially those who recovered. In reviewing the whole series, it is clear that in general, the older the child the better the prognosis. Whether age is the chief factor in the recovery of these children it is difficult to state because of insufficient controls. Most of the children over 2 years of age were treated surgically while most of the younger children were not treated surgically. It is interesting to note that 2 children who recovered, aged 20 months and 4 years, respectively, drained spontaneously from the umbilicus.

The use of serum has been advocated in pneumococcus peritonitis for some years. The reports in the literature have included excellent results as well as failures. Since the recent reports on anti pneumococcus rabbit serum in the treatment of lobar pneumonia at the Rockefeller Institute it seems likely that this type of serum may be of benefit in the treatment of primary peritonitis. According to Horsfall et al. horse serum anti bodies have never been demonstrated in the pleural effusions of pneumococcus empyema, while the smaller rabbit serum anti bodies readily diffuse into the pleural cavity. This same principle may apply to the peritoneum although the fact has not yet been definitely demonstrated.

Rabbit serum was given to only one patient with primary peritonitis and it apparently contributed to the recovery of this patient. It may develop that serum therapy will supplant the necessity of operation after a study of a large series of such cases.

In considering the differential diagnosis, it must be remembered that, unlike the streptococcal cases, the age incidence in pneumococcus peritonitis parallels the age incidence for appendicitis in children fairly closely, and sometimes appendicitis cannot be ruled out unless a positive peritoneal puncture has been obtained so that operation may be indicated. Case 1 reported below illustrates the difficulty which is encountered in making a proper diagnosis. While studying the present series the author examined a colored girl, age 6 years, who was thought to have a ruptured appendix with generalized peritonitis. The diagnosis seemed so definite that pneumococcus peritonitis was not even considered, and operation was recommended. At laparotomy this proved to be a case of pneumococcus peritonitis.

It is suggestive but not conclusive that the proper treatment of pneumococcus peritonitis in the majority of acute cases is early surgical exploration with bilateral drainage in both lower quadrants, preferably by a laparotomy incision on the right and a small stab wound on the left. This is the method which most of the surgical cases have received. Supportive measures in the form of intravenous fluids and small transfusions, should be given as indicated. Nothing should be given by mouth until all nausea and vomiting have ceased. As soon as the pneumococcus has been typed serum therapy should be given when possible.

**CASE 1.** A colored girl, age 6 years, was seen in the Harriet Lane Dispensary on February 25, 1938, complaining of abdominal pain and vomiting for 2 days. The pain was said to have started in the right lower quadrant which became worse after the mother had given the child castor oil. Physical examination revealed an acutely ill child with a temperature of 101.4 degrees, pulse 140, respiration 20, white blood count 25,000, urine negative and vaginal smear negative for gonococci. Distention was not marked but there was generalized lower abdominal tenderness and moderate muscle spasm. Rectal examination revealed tenderness on both sides but no masses. The throat, heart and lungs

were negative. A diagnosis of appendicitis with peritonitis was made. After intravenous fluids, laparotomy was performed which revealed a generalized peritonitis which was thought to be of gonococcal origin although the fallopian tubes were not greatly inflamed. A normal appendix was removed and the wound closed without drainage. The report of the culture 2 days later from the peritoneal pus was pneumococcus Type I. This was also confirmed on the same day by blood culture. During the interval, the child had declined steadily with frequent vomiting, delirium, temperature 104.6 degrees, and the pulse rate averaging around 170 to 190 despite continuous intravenous therapy. As soon as the cultures were reported, she was transferred to Harriet Lane where, after negative conjunctival and intradermal test doses, a total dose of 295,000 units of anti-pneumococcus rabbit serum was given intravenously at 2 hour intervals over a period of 12 hours. There was rapid improvement, the temperature falling to 99.4 degrees at the end of 24 hours. She received 2 small transfusions of 150 cubic centimeters each on March 2 and March 8, 1938. The only serum reaction was a chill after the first injection and some incontinence 1 week later.

The ultimate recovery of this patient was long and protracted. Twenty-two days later the patient developed a consolidation of the lower lobe of the left lung, which was shown by x-ray. This cleared up but a mechanical intestinal obstruction developed which necessitated an exploratory laparotomy on April 19 and again on April 27 with release of adhesions and evacuation of a small pocket of pus. Culture of this pus was sterile. After this the patient steadily improved and was discharged May 16, 1938, more than 2½ months after admission.

Another interesting case of pneumococcus peritonitis has recently been admitted which is almost identical with the case just reported. The prompt improvement after receiving anti-pneumococcus rabbit serum warrants a preliminary report:

A colored girl, 8 years of age, was admitted on March 27, 1938, acutely ill with signs of generalized peritonitis. She had been sick for 2 days complaining of abdominal pain which began in the right lower quadrant. Vomiting and diarrhea followed 8 hours after the onset of her illness. She had been given castor oil on 2 occasions. At exploratory laparotomy, the appendix was normal but there was a generalized peritonitis from which a smear and culture were taken. Type I pneumococcus was typed from the smear and was later grown from the peritoneal and blood cultures. She received 300,000 units of anti-pneumococcus rabbit serum in the same manner as Case 1 with prompt improvement. Her convalescence was satisfactory until the patient developed a peritoneal abscess which was incised

and drained, pneumococci being cultured from the abscess. After this procedure, the patient improved more rapidly and was discharged on April 20, 1938, 24 days after admission to the hospital.

#### STREPTOCOCCUS PERITONITIS

*Clinical* These cases have been divided into 2 groups the idiopathic group and the group associated with erysipelas. In the idiopathic group, there were 17 cases with a mortality of 88.2 per cent. There were 11 males and 6 females. In the erysipelas group the mortality was 100 per cent, there being 8 cases, 4 males and 4 females. Race is apparently of no importance in either the streptococcus or pneumococcus group, the proportion of white to colored children being approximately the same as the general admissions to the hospital.

The age incidence for streptococcus peritonitis differs considerably from the cases of pneumococcus peritonitis, most of these cases occurring in the first 6 months of life (18 of the 25 cases). This is of importance in diagnosis, as appendicitis in children is extremely uncommon before the age of 2 years according to Lipshultz, Lowenburg, Marsch, and others. Marsch's figures for 9,000 cases of appendicitis reveal that only 1.1 per cent occurred between the ages of 1 and 5 years.

The most important symptoms in the cases of streptococcus peritonitis in the order of their frequency are vomiting, diarrhea, and abdominal pain. Many of these children are too young to reveal pain except by fretfulness and crying, particularly when the abdomen is touched.

The more important signs are an acutely ill, often moribund, child with considerable abdominal distention. The abdomen is tender to palpation but not board-like. In several of the cases the umbilicus and surrounding area for about 2 centimeters were red and swollen. Unfortunately, this is a late sign, which usually is seen in moribund infants. The children may have evidence of a streptococcus infection elsewhere, such as a pharyngitis, a cellulitis of the skin, or an otitis media. Leopold and Kaufman quote Mordlund's series of primary streptococcus peritonitis in which 63 per cent of the cases have a preceding upper respiratory infection.



The cases of primary streptococcus peritonitis all appear to have a fulminating type of the disease there being no subacute or chronic types. The temperature is high from 103 degrees to 106 degrees the white blood count ranges between 2700 and 45000. The low white blood count occurs not infrequently, along with a subnormal temperature in children who are moribund and in shock.

In the cases associated with erysipelas peritonitis usually develops as soon as the infection spreads to the region of the umbilicus. This would suggest that the infection of the peritoneum occurs by direct extension although a septicemia is usually present by this time. Study of the cases at autopsy suggest this mode of extension in 1 and perhaps 2 cases, but this cannot be shown in all cases.

Differential diagnosis consists in ruling out an acute dysentery, appendicitis, meningitis, and a severe respiratory infection. The peritoneal puncture is perhaps more valuable in these cases than in the pneumococcus group. Since the introduction of sulphanilamide, differentiation between streptococcus and pneumococcus is extremely important therapeutically.

**Treatment.** The conservative treatment of streptococcus peritonitis appears to offer the most at the present time, since the use of sulfanilamide has been shown to be of such value in Beta streptococcus infections. In reviewing the present series of cases the mortality rate was 100 per cent in the 9 patients operated upon and 87.5 per cent in the 16 patients treated without operation. So far sulfanilamide therapy has been given to 3 patients with primary streptococcus peritonitis 2 of whom died and the third a premature infant of 2 months recovered. This case is reported below. The first patient who received sulfanilamide was a boy, aged 4 months who had a laparotomy with drainage in December 1936. Beta streptococcus was cultured and sulfanilamide given subcutaneously. The child survived longer than usual but died on the twelfth day. The other patient to receive sulfanilamide was admitted moribund and died within 6 hours.

In summarizing it should be emphasized that in the treatment of streptococcus peri-

tonitis early diagnosis is of the greatest importance. This can usually be confirmed by peritoneal puncture eliminating the necessity for laparotomy. Sulfanilamide should be given as early as possible. The patient who recovered was given sulfanilamide both subcutaneously and intraperitoneally. Normal saline and sodium lactate were also given intravenously to prevent acidosis, which occurs so readily when administering sulfanilamide to infants, supportive measures were given as indicated.

**CASE 2.** A premature colored boy was admitted to the Harnet Lane Home at the age of 1 day because of prematurity. His course was uneventful until the age of 2 months when he developed a severe respiratory infection accompanied by vomiting, diarrhea and severe distention. Physical examination at that time revealed an acutely ill child with a temperature of 104 degrees, pulse rate threadly, respiration laborious and a white blood count of 12700. The urine was negative on examination. The abdomen was distended and there was definite generalized tenderness. A peritoneal puncture was performed and 5 cubic centimeters of purulent material obtained. A smear revealed streptococci in chains and the culture report was Beta streptococci. By 6 o'clock in the evening on November 28, 1937 the child was in shock and one half cubic centimeter of coramine was administered. The first dose of sulfanilamide (30 cubic centimeters of a 1 per cent solution) was given intraperitoneally at 11 o'clock that night. The child received a second dose of 30 cubic centimeters intraperitoneally the next morning along with subcutaneous infusions of a 1 per cent solution twice a day for 5 consecutive days. The average subcutaneous dose was 40 cubic centimeters or 0.4 gram of sulfanilamide. A one sixth molar solution of sodium lactate was given along with the sulfanilamide to combat acidosis. Frequent small blood transfusions of 30 to 40 cubic centimeters were also given. Under this regimen the infant improved steadily. Two weeks later a scrotal abscess developed. This was incised and drained. Beta streptococci being obtained from the culture. Sulfanilamide was again given along with 3 additional blood transfusions. The infant recovered and was discharged on January 1, 1938, 2 months after the peritonitis developed. This is apparently the youngest case which has recovered from a primary streptococcus peritonitis that has been reported in the American literature.

#### BACTERIOLOGY AND PATHOLOGY

The question of the etiology and the mode of entrance of the organisms into the peritoneal cavity is discussed in most papers on primary peritonitis. The 3 modes of entrance

generally considered are: (1) the blood stream, (2) the intestinal tract, and (3) the genital organs of the female. Perhaps the viewpoint of Cole who thinks that there is probably more than one avenue of entrance is most logical. The blood stream seems to be the most common pathway, but why the peritoneum is selected by the organisms is open to speculation. A careful study of the 36 autopsies in this series does not aid in clarifying this point. Studies from a physiological viewpoint might prove helpful.

A study of the cultures of the organisms obtained in these 2 groups is of interest. The typing of the pneumococcus is important in selecting the cases in which horse or rabbit anti-pneumococcus serum may be readily used. Thus in the 36 cases the type of pneumococcus was as follows: Type I, 5 cases, Type II, 4 cases, Type III, 2 cases, Group IV, 14 cases, not typed, 11 cases, total number of cases 36.

A positive blood culture was obtained either before or after death in 17 of the 25 cases in which it was attempted, the vast majority being premortem cultures. In the 29 cultures of the peritoneal material all were positive for pneumococcus. Eleven throat cultures were taken, 8 of which were positive with the same type pneumococcus as was obtained from the blood or peritoneal culture. Sporadic cultures were also taken from the vagina, spinal fluid, colon, and lungs. There were 6 positive lung cultures and no positive vaginal cultures with the same type organism as in the blood or peritoneum.

In considering the bacteriology of the 25 streptococcus cases, the Beta streptococcus was cultured from either the blood or peritoneal fluid in 24 cases, an unusual Gamma streptococcus being cultured from both the blood and the peritoneal fluid in the other case. There were 21 positive blood cultures and 4 negative cultures. There were also 21 positive peritoneal cultures and 1 negative culture. Sporadic cultures were also taken from the vagina, urine, stools, spinal fluid, throat, lungs, and skin. There were 5 positive and 2 negative throat cultures and unlike the pneumococcus group, there was 1 positive and 1 negative vaginal culture. There was

also 1 positive culture from a scrotal abscess, and 4 positive cultures from the skin of erysipelas patients.

#### SUMMARY AND CONCLUSIONS

Twenty-five cases of primary streptococcus peritonitis and 36 cases of primary pneumococcus peritonitis have been studied. One case of primary streptococcus peritonitis which recovered with sulfanilamide therapy, has been reported in detail. One case of primary pneumococcus peritonitis, Type I, which reacted favorably to anti-pneumococcus rabbit serum Type I, has also been reported in detail. The clinical findings, bacteriology, pathology, and treatment have been analyzed. No definite avenue of entrance could be found to explain the spread of the organisms into the peritoneal cavity, but it seems likely that there are several pathways of entrance, the blood stream being the most common way through which the organisms reach the peritoneum.

The mortality figures are quite high for both the streptococcus and pneumococcus cases of primary peritonitis. Two newer methods of treatment, i.e., sulfanilamide, and anti-pneumococcus rabbit serum, are reported, and it is hoped that after a longer period of trial the mortality figures will be reduced considerably by these methods. In considering the surgical results of these 61 cases, it is suggestive that early laparotomy with drainage is of definite value in selected cases of pneumococcus peritonitis, and of no value in the cases of streptococcus peritonitis.

A summary has been made of the 36 cases of streptococcus and pneumococcus peritonitis which came to autopsy in the department of pathology.

No mention has been made of primary peritonitis in adults although it does occur less commonly than in children. Two fulminating cases of adult Beta streptococcus peritonitis have come to autopsy this year in which the infection was thought to have arisen in association with chronic gonococcal salpingitis.

The author wishes to express his appreciation for the permission given him by Dr. Edwards A. Park to include the cases from the department of pediatrics of the Johns Hopkins Hospital in this report, and to Dr. Charles Geschickter and Dr. Arnold Rich for their constructive suggestions.

## BIBLIOGRAPHY

- 1 CABOT R Acute generalized streptococcus peritonitis New England J Med 1937 216 983-987
- 2 COLE W H Primary pneumococcus peritonitis Surgery 1937 1 386-394
- 3 DANZER B S Diagnosis peritonitis in children J Pediat 1936 8 741-747
- 4 CLAZIER M M GOLDBERT B I WEINSTEIN A A Primary pneumococcus peritonitis recovery with use Type I serum Ann Int Med 1937 10 1042-1049
- 5 HORSFALL I L Jr COODNER A MACLEOD C M HARRIS A A Antipneumococcus rabbit serum as a therapeutic agent in lobar pneumonia J Am Ass 1937 108 1483
- 6 HORSLEY J S Peritonitis Arch Surg 1935 36 190-224
- 7 LAZARUS S D Acute peritonitis in children Am J Surg 1932 17 70-73
- 8 LEOPOLD J S KALEMAN R E Acute primary streptococcus peritonitis J Pediat 1937 10 45-61
- 9 LIPSHITZ B LOWENBURG H Pneumococcus and streptococcus peritonitis J Am M Ass 1926 86 90-104
- 10 LOWE H A Primary pneumococcus peritonitis J Missouri M Ass 1936 33 353-356
- 11 LOWENBURG H NEMSER S Hemolytic streptococcus peritonitis with recovery Arch Pediat 1936 53 753-759
- 12 MCCARTNEY J E and FRASER J Pneumococcus peritonitis Brit J Surg 1921 9 479
- 13 NATHOR C and COHEN IRA Abdominal puncture and diagnosis of acute peritonitis Ann Surg 1926 83 454-462
- 14 POLLOCK L H Primary streptococcus peritonitis Arch Surg 1936 53 714
- 15 SCHMANNING C K Primary pneumococcus peritonitis Acta chirurg Scand 1935 77 256-268

# ARRHENOBLASTOMA

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IN 1905, Pick, of Germany, first described a peculiar ovarian tumor composed, in the main, of epithelial elements in tubular arrangement different from any structure found in a normal ovary but bearing a strong resemblance to adenomatous tissue found and described in connection with the gonads of male pseudohermaphrodites. He considered this tumor as being of the nature of an enlarged ovotestis and called it a testicular tubular adenoma. Schickele, in 1907, and Bell of England, in 1915, reported similar examples, the latter giving a detailed report of a girl, aged 18 years, who presented a symptom complex consisting of amenorrhea, hirsutism with a male distribution of hair, atrophy of the breasts, changes in the voice, and the presence of a left ovarian tumor. The syndrome, which had developed within a period of 18 months, retrogressed completely to a condition of normalcy following removal of the affected ovary. Pathological study of the surgical specimen revealed what Bell considered an example of a tumor in an ovotestis. He described, along with the tubular and adenomatous structures noted by Pick, certain interstitial cellular elements which, when stained with sudan III, were seen to contain lipid within their cytoplasm.

Meyer, over the period from 1915 to 1918, in an extensive study, found 17 instances of ovarian tumor of a similar nature. He noted the frequent occurrence of the peculiarly associated symptom complex and gave the tumor the name it now bears, "arrhenoblastoma." His work on the histogenesis of this tumor brought him to the conclusion that it arose from undifferentiated testicular remnants caught up in the ovarian hilus during early embryological development. From his rather large bulk of material he found that there were 3 pathological types of arrhenoblastoma: (1) that having a tubular pattern,

(2) that having a diffuse or sarcomatoid structure, and (3) that representing an intermediate form in which the cellular elements of the tumor had a cylindroid arrangement. He recognized that the masculinizing syndrome was associated principally with the latter 2 types. He regarded the tumor as being of a low grade of malignancy, only one of his patients dying of metastasis, although several of his patients went through normal pregnancies following removal of the tumor.

Moots, in 1921, described the first case reported from this continent. In spite of a typical clinical and pathological picture of arrhenoblastoma and the fact that his patient had a complete return to normal following operation, he described the condition in the older terminology of "lateral partial glandular hermaphroditism."

Popoff, Spielman, Novak and Long, Mathias, Meyer, and more recently McLester, have reported cases of arrhenoblastoma. In 1933, there were some 26 cases reported in the literature, since then this number has been increased to more than 30.

## HISTOGENESIS

As with the origin of other tumors of the ovary, there is no universal agreement regarding the parent tissue from which these tumors develop. Meyer, Goodall, Novak, and others champion the theory that these tumors arise from embryonic rests in the ovarian hilus and that these rests differentiate along male lines. Meyer has found embryonic remnants of seminiferous tubules in the hilus of otherwise normal ovaries, and Popoff discovered a small nodule arising from similar structures resembling in miniature the picture of arrhenoblastoma. The tumor studied in the case reported by Bell was only the size of a plum and appeared to arise from hilar structures because it possessed, at the periphery, an

From the Division of Pathology, The Mayo Foundation, and the Section on Pathology, The Mayo Clinic



Fig 1



Fig 2



Fig 3

Fig 1 Case 1 Showing absence of adhesions.

Fig 2 Case 1 Alveolar arrangement of cells. Note areas of dark staining interstitial cells (sudan III  $\times 30$ )

Fig 3 Case 2 Showing typical characteristics of testicular tubular adenoma. Few interstitial cells are noted  $\times 120$

investment of ovarian cortical tissue. Others, prominent among whom is McLester, believe that the tumor represents a one-sided development of a teratoma. In the tumor reported by McLester there were cysts lined with large mucus-producing cells bearing no resemblance to normal ovarian structures or to the cellular elements in other parts of the tumor. He pointed out the fact that, in some instances, it may be difficult to find anything except thyroid tissue in an ovarian teratoma and postulated that the same is probably true as far as testicular elements are concerned. The question is still unsettled.

#### PATHOLOGY OF ARRHENOBLASTOMA

The gross appearance of these tumors is more or less characteristic. Meyer Neumann, and McLester noted the smooth grayish surface without adhesions and without invasion by tumor cells. As in Bell's and Neumann's cases this is supposed to represent the stretched-out remains of ovarian cortex the tumor arising from medullary remnants. Microscopically Meyer found 2 cellular types: the large polygonal cell with clear cytoplasm and a dark-staining clearly outlined nucleus with a prominent nucleolus. The other was a spindle cell which he considered

to be a modified epithelial cell. The epithelial elements were arranged in 3 definite patterns: (1) an alveolar or tubular pattern with central lumens either empty or containing a homogeneous secretion, the lining cells being large polygonal and in orderly arrangement; (2) a disposition in solid cords or anastomosing strands, the so-called intermediate group; and (3) a diffuse or sarcomatoid arrangement. Mitotic figures have been found but are not frequent and the degree of differentiation together with this and other features indicate a low grade of malignancy.

Spielman, Bell, and, more recently, McLester, have demonstrated the presence of lipid globules within the cytoplasm of both the large polygonal cells and the fusiform cells. These droplets are supposed to have a peculiar disposition in a crescentic fashion around vacuoles in the cytoplasm. The picture closely resembles that of the interstitial cells of the testis studied by Crew, and these peculiar cells are purported to play the role of producing the secondary sex characteristics observed through the elaboration of the male sex hormone. In the first 3 cases reported below lipid droplets were a prominent feature in the cytoplasm of the large polygonal cells. In the second case a gradual transition is seen between these epithelial elements and



Fig 4 a

Fig 4 Showing multicentric character of tumor which was noted in all 4 cases a, above, Case 2, b, below, Case 4

the so called interstitial cells mentioned by other writers

#### CASE REPORTS

The following 4 examples of arrhenoblastoma were found in an examination of the material collected from the museum of The Mayo Clinic in the period from 1910 to 1936 inclusive. The tissue was old and fixed in formalin and the histories were not taken with special reference to a diagnosis of this type of neoplasm, but the cases contain so much of interest from clinical and patho-



Fig 5 Case 3 Showing smooth, rounded contours of the tumor

logical standpoints that they deserve more than passing consideration. Multiple blocks were taken from these tumors and were studied from frozen and paraffin sections. They were stained with hematoxylin and eosin, sudan III, and by the Galantha method for mucin.

**CASE 1** A married, white primipara, aged 25 years, registered at the clinic October 15, 1934. Her past medical history was negative except for having had an appendicectomy performed in 1926, at which time pelvic exploration had revealed no abnormality. In 1930 she had experienced a normal pregnancy.

Her present illness had dated back  $2\frac{1}{2}$  years when, following 4 months of menorrhagia, her menses had suddenly ceased. Coincidentally with

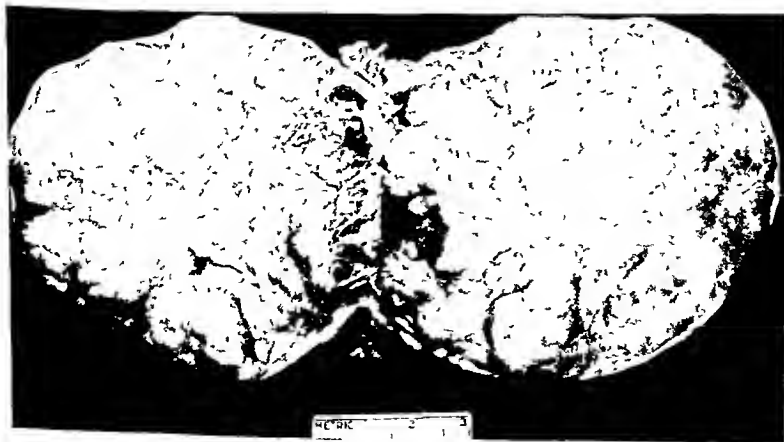


Fig 4 b



Fig 1



Fig 2



Fig 3

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Fig 2 Case 1 Alveolar arrangement of cell. Note areas of dark staining interstitial cell (sudan III  $\times 30$ )

Fig 3 Case 2 Showing typical characteristics of testicular tubular adenoma. Few interstitial cells are noted  $\times 120$

investment of ovarian cortical tissue. Others, prominent among whom is McLester, believed that the tumor represents a one sided development of a teratoma. In the tumor reported by McLester, there were cysts lined with large mucous producing cells bearing no resemblance to normal ovarian structures or to the cellular elements in other parts of the tumor. He pointed out the fact that in some instances, it may be difficult to find anything except thyroid tissue in an ovarian teratoma and postulated that the same is probably true as far as testicular elements are concerned. The question is still unsettled.

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extending half way to the umbilicus, and (4) blood pressure of 165 millimeters of mercury systolic, and 90 diastolic

At operation on March 26, 1931, a hysterectomy and bilateral salpingo-oophorectomy were performed for a solid neoplasm of the left ovary. Fifty cubic centimeters of straw colored fluid were present in the pelvis but evidence of local extension or of distant metastasis was not found.

This patient was given a course of colloidal lead phosphate intravenously. Six months later at a subsequent examination, there was no evidence of recurrence. Hypertichosis was still present although not to such a severe degree as formerly.

On pathological examination, the uterus, right tube, and right ovary presented no remarkable features. The left ovary was replaced by a solid mass measuring 20 by 15 by 14 centimeters of smooth surface and without adhesions. On section, as in Case 1, the neoplasm contained multicentric grayish brown nodules of tumor tissue separated from one another by trabeculae of connective tissue and containing in their center tiny cystic spaces filled with coagulated fluid (Fig 3). Surrounding the tumor proper was a ring of edematous ovarian stroma 3 millimeters in thickness (Fig 4).

Microscopically the picture differed little from that of Case 1 except for a relative absence of *interstitial* cells and the presence of small cysts. All these cysts were lined with a type of epithelium similar to that forming the tubular structures of which the tumor was mainly composed. Stains for lipid demonstrated but minimal amounts of this substance, the tumor being an almost pure testicular tubular adenoma (so called).

CASE 3. A single, white nullipara, aged 15 years, registered at the clinic on March 1, 1937, complaining of amenorrhea and an abnormal growth of hair over the body. Her family history and personal history had been essentially negative except for an appendectomy for acute appendicitis at the age of 13 years. Menses had begun at the age of 12 years and, for 12 months, had been regular. Following her appendectomy she did not menstruate for 2 months and then had one period of scanty flow. She had not menstruated since then. Nine months prior to admission she had noted that her voice was becoming husky and, several months later, had observed atrophy of the breasts. For 3 months there had been a definite growth of facial, axillary, and pubic hair. A persistent acne had developed.

Positive physical findings were limited to the coarse voice, hypertichosis with a male pattern of distribution, atrophy of the breasts, and hypertrophy of the clitoris. There was an acneiform type of cutaneous eruption. Pelvic examination disclosed a right ovarian tumor. Her blood pressure was 118 millimeters of mercury systolic, and 80 diastolic. Her basal metabolic rate was minus 7.

At operation on March 4, 1937, a right salpingo-oophorectomy was done for a solid tumor of the right ovary. The uterus appeared small. The left adnexa

were grossly normal. The patient was discharged on the fifteenth postoperative day. At a subsequent visit 3 months later she was menstruating regularly and there was great diminution of her previous symptoms of masculinization. Urinary estimations for prolactin gave negative results.

On pathological examination, the right ovary was the site of a solid tumor measuring 7 by 6 by 5 centimeters. This tumor had the same general gross characteristics as those described in Cases 1 and 2 (Fig 5). Microscopically the tumor had all the features which mark the maturation of an arrhenoblastoma. The majority of sections had a diffuse arrangement of closely packed oval dark staining cells. In other regions, the picture was that of cuboidal dark staining cells arranged in solid cords (Figs 6 and 7). Careful search revealed a tubular arrangement with transition to the other patterns in many areas. Scattered diffusely, or aggregated in small groups, were large pale cells with vacuolated cytoplasm. Stains for fat demonstrated the presence of lipid droplets within the cytoplasm of these cells. Sections through the capsule of the tumor revealed many small graafian follicles containing degenerated ova. Corpora lutea were not seen. This tumor represents the type of arrhenoblastoma which, as Meyer has pointed out, is almost invariably productive of the masculinizing syndrome (Fig 8). This illustration presents a diffuse pattern with a large number of pale, interstitial cells, associated with extreme signs of masculinization.

CASE 4. A white multipara, aged 51 years, registered at the clinic on May 2, 1930, because of postmenopausal bleeding. Her family history and personal history were negative. Her menses, prior to the climacterium at the age of 48 years, had for years been irregular, scanty and, at times, were spaced 3 to 4 months apart. During the 2 years prior to registration she had experienced 2 prolonged episodes of daily vaginal spotting. The last episode had begun 4 months prior to admission and had continued until the time of admission. Examination revealed multiple uterine fibromyomas and a firm mass in the right side of the pelvis. Laboratory data were negative.

At operation on May 9, 1930, a total abdominal hysterectomy was done with removal of both adnexa for uterine fibromyomas and a right ovarian tumor. The patient had an uneventful convalescence and was given a course of deep roentgen therapy before she went home. She was living when last heard from in 1937.

On pathological examination, the uterus was the site of multiple fibromyomas measuring as much as 4 centimeters in diameter (Fig 4). There was an endometrial polyp at the fundus. Both tubes and the left ovary were essentially normal. The right ovary was the site of a solid tumor of a description similar to that of the other cases. Microscopically, as in Case 3, the tumor contained all 3 cellular patterns of Meyer's classification. There was, however, an almost complete lack of interstitial cells.





Fig 6

Fig 6 Case 3 Mixed type of arrhenoblastoma showing tubular elements  $\times 250$



Fig 7

Fig 7 Case 4 Cylindroid pattern predominates  $\times 175$

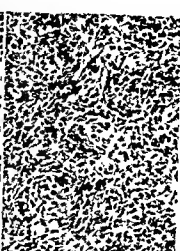


Fig 8

Fig 8 Case 3 Diffuse pattern with a large number of pale interstitial cells associated with extreme signs of masculinization  $\times 175$

the onset of amenorrhea she had noted an overgrowth of facial hair which had gradually increased in amount until shaving had become a frequent necessity. She had gained 20 pounds since the beginning of her illness and had complained of recurrent attacks of mild pain in the left lower abdominal quadrant.

Physical examination revealed an obese white woman with a somewhat boyish figure and a distinctly masculine distribution of hair. There was extreme hypertrophy of the clitoris and moderate atrophy of the breasts. Erythematous patches were present in the skin over both legs. Pelvic examination disclosed a tender mass in the left adnexal region. Her blood pressure was 98 millimeters of mercury systolic and 60 diastolic. The only positive laboratory finding was the Allen Doisy reaction for an excess of urinary prolactin (66 units). Roentgenological examinations of the cells gave negative results. The basal metabolic rate was minus 9.

At operation on October 23, 1934, a solid tumor of the left ovary was removed and a biopsy was performed on the right ovary. Convalescence was uneventful and the patient returned home on the thirteenth postoperative day. Twenty-eight days following her operation she had a normal menstrual period. One year later she gave birth to a baby boy.

At a subsequent examination, 2 years after her first visit, the right ovary was palpably enlarged. There was still present moderate hirsutism and the clitoris still was somewhat enlarged. Tests of the urine for prolactin, however, gave negative results.

On pathological examination the solid tumor was 5 centimeters in diameter and its surface was smooth and glistening (Fig 1). On section the mass was grayish-tan in color and solid throughout but with

multicentric nodules of greater density. Microscopically, in the capsular zone of the tumor there were graafian follicles and corpora albicantes; the stretched-out remnant of normal ovarian tissue. Underneath this the tumor contained trabeculated strands of large polyhedral cells in tubular or alveolar arrangement but with intervening solid cords of pale staining interstitial cells (Fig 2). The cytoplasm of the polyhedral cells was clear or finely reticulated; the nuclei were small and dark staining with nucleoli relatively pin-point in size. Mitotic figures were scarce. Stains for lipid showed the presence of fatty droplets in the cytoplasm of both cellular types but without any special intracellular distribution. The typical sarcomatoid pattern was not observed. The entire picture resembled that characteristic for the group classified by Meyer as not usually giving rise to symptoms of masculinization. Evidence pointing to a teratomatous origin of this tumor could not be found. Sections of the specimen removed from the right ovary for biopsy were normal.

CASE 2 A single white nullipara aged 31 years registered at the clinic March 20, 1931. She complained of an abdominal swelling and hypertrichosis of 2 years' duration. Her family history and personal history were irrelevant. Her menses had been regular until 3 months prior to registration when her period stopped abruptly. This was followed by 2 episodes of bleeding regularly spaced but small in amount. There had been considerable gain in weight over the period of her present illness.

Examination revealed the following positive features: (1) pituitary type of adiposity; (2) heavy growth of hair over the body with a masculine type of distribution; (3) hard pelvic abdominal tumor

- 13 NOVAK, EMIL, and LONG, J H Ovarian tumors associated with secondary sex changes Granulosa cell carcinoma and arrhenoblastoma. J Am M Ass, 1933, 101 1057-1063
- 14 PHELAN, G W A defeminizing tumor Am. J Obst. & Gynec, 1934, 27 748-750
- 15 PICK, LUDWIG Ueber Adenome der maennlichen und weiblichen Keimdruese bei Hermaphroditismus verus und spurius Nebst Bemerkungen ueber das endometriumaechnliche Adenom am inneren weiblichen Genitale Berl klin Wchnschr, 1905, 17 502-509
- 16 POPOFF, N W Testicular tubular adenoma of the ovary its etiologic relation to embryonic vestiges and spontaneous sex reversal of the female gonads Report of a case Arch Path, 1930, 9 31-53
- 17 SCHICKELE, G Adenoma tubulare ovarii (testiculare) Beitr z Geburtsh u Gynaek, 1906, 11 263-268
- 18 SCHILLER, W S Personal communication to the authors
- 19 SPIELMAN, FRANK Tubular adenoma (arrhenoblastoma) of the ovary. Am. J Obst & Gynec, 1933, 25 517-521
- 20 TAYLOR, J M, WOLFERMANN, S J, and KROCK, FRED Arrhenoblastoma of the ovary Surg, Gynec & Obst, 1933, 56 1040-1046
- 21 v SZATHMÁRY, Z Ueber eine virilisierende Ovarialgeschwuelst (Arrhenoblastoma ovarii) Arch f Gynaek, 1934, 157 170-186
- 22 WHITEHEAD, R. H. On the chemical nature of certain granules in the interstitial cells of the testis Am J. Anat, 1912, 14 63-71

## DISCUSSION

In the presence of a palpable pelvic tumor, associated with the masculinizing syndrome, a diagnosis of arrhenoblastoma seems justified. However, basophilic pituitary adenomas, pinealomas and adrenal cortical tumors may be associated with a similar clinical picture. Certain features help in distinguishing between them. Hypertension, a cardinal symptom of adrenal and pituitary neoplasms, is unusual in cases of arrhenoblastoma. A definite increase in weight with a "buffalo" distribution of fat is associated frequently with an adrenal or pituitary neoplasm but may occur in association with ovarian tumor. Acne seems to occur frequently with all these conditions and was observed in 2 of the cases studied. Pituitary changes of a hyaline nature have been encountered in cases in which death has occurred owing to arrhenoblastoma. This leads to the question of whether or not this master gland may not be the basis of secondary sex changes. Positive prolan tests would point to such a conclusion.

Granulosa cell tumors offer the only difficulty in making a differential diagnosis histologically. The pathological characteristics of both tumors have a certain similarity but interstitial cells are absent in granulosa cell neoplasms and tubular structures are almost never observed. From a hormonal standpoint they are entirely different, granulosa cell tumors containing large amounts of estrin without prolan and the reverse being true in cases of arrhenoblastoma.

Most authors are now agreed that more than 80 per cent of these tumors are clinically benign. Malignancy in an arrhenoblastoma is shown by the usual criteria of multiple mitotic figures, irregularity in the size and staining properties of the nuclei and local invasion. It can be recognized in fresh sections of tumor tissue and, when present, warrants radical operation. Treatment, especially among younger individuals, should otherwise be conservative.

There are cases on record like Case 2 in the present series, in which pregnancy has ensued following local resection. Recurrences in the preserved ovary are infrequent. Little is known of the effect of radiation on these tumors because of the small number of re-

ported examples. Some authors hold that arrhenoblastomas are highly radiosensitive.

## SUMMARY AND CONCLUSIONS

- 1 Four cases of arrhenoblastoma are presented.
- 2 The clinical syndrome of sterility with amenorrhea, hirsutism, atrophy of the breasts, hypertrophy of the clitoris, and changes in the voice were all noted in 2 cases. In one case absence of follicular hormone with an increase of anterior pituitary hormone was found on examination of the urine.
- 3 Production of hormone by these tumor cells is probably linked up with lipid metabolism.
- 4 These tumors are of but a low grade of malignancy, in most instances responding well to local surgical removal.
- 5 These tumors probably arise from embryonic structures within the ovarian hilus, growing and differentiating along male lines.

## REFERENCES

- 1 ALLEN EDGAR: Sex and internal secretions. Baltimore: The Williams & Wilkins Co. 1932.
- 2 BENZELD MOSES and LEVINE SAMUEL: Arrhenoblastoma of the ovary: testicular adenoma tubulare. Arch Surg 1936 33 392-396.
- 3 BELL W. B.: So-called true hermaphroditism with report of a case. Proc Roy Soc Med (Sect Obst and Gynec) 1913 Pt 1 8 17-23.
- 4 BENTZEL ERICH: Zur Frage der Vermaennlichung geschwuelter des Eierstockes (Arrhenoblastoma ovarii Meyer) nebst Mitteilung von zwei neuen Faellen. Arch f path Anat u Physiol 1934 104 33-64.
- 5 FELL H. B.: Histological studies on the gonads of the fowl. I. The histological basis of sex reversal. Brit J Exper Biol 1923 1 97-130.
- 6 GNASSI A. M.: Multiple arrhenoblastoma of the ovary. Am J Obst & Gynec 1936 31 135-139.
- 7 GOODALL J. R.: The origin of epithelial new growths of the ovary. Surg Gynec & Obst 1912 14 584.
- 8 MADHUS ERNST: Bericht ueber ein operativ entferntes Arrhenoblastom mit spaeterer Schwangerschaft gleichzeitig ein Beitrag zur Lehre von den hormonal-aktiven Gewachsen. Zentralbl f Gynaek 1933 57 440-455.
- 9 McLESTER J. B.: Arrhenoblastoma: a special type of teratoma: report of a case. Arch Int Med 1936 57 773-786.
- 10 MEYER ROBERT: The pathology of some special ovarian neoplasms and their relation to sex characteristics. Am J Obst & Gynec 1931 22 691-713.
- 11 MOORE C. B.: Lateral parial glandular hermaphroditism. Am J Obst & Gynec 1925 1 864-867.
- 12 VERMANN H. O.: Analoge Keimepithelblastoeme der Hoden und der Ovarien sowie ihr Vorkommen beim menschlichen Zwitter oder Scheinzwitter. Arch f Gynaek 1925 131 477-573.

series exhibited this deformity. Posterior displacements of a vertebral body are frequently observed developmentally and as a result of trauma

Five patients in this series presented an increase in the anterior displacement of the affected vertebral body while under observation, varying from one sixteenth to five-eighths inch. It is noteworthy that 2 of these patients developed spondylolisthesis following previous definite roentgenographic evidence of spondylolysis. These patients were all under treatment during the period of observation, and in no case was additional trauma recorded while the patient was being followed. The paucity of cases and the slight degree of increased slipping of the affected vertebra would tend to indicate that there is not a marked tendency for the deformity to increase

It is of unusual interest to report that 2 patients in the total number of cases, both of whom presented symptoms and roentgenographic evidence of typical spondylolisthesis of the fifth lumbar vertebra, have subsequently become married to each other. Two children have been born, and recent roentgenographic studies have been made of the lumbosacral spines of these children, both males. In the first child, now 17 years of age, an incomplete sacralization of the fifth lumbar vertebra is present. In the second child, now 12 years of age, there is evidence of spondylolysis of the fifth lumbar vertebra.

Since no disease process is known which is likely to produce a narrow transverse defect of one or both laminae of a lumbar vertebra, and since pathologists have reported no surrounding soft tissue involvement, inflammation may be ruled out as the etiological factor in spondylolisthesis. Belief that the lesion is congenital in nature is favored by lack of evidence at the time of operative procedures or postmortem examinations of callus formation at the site of the defect. No one has presented a case of spondylolisthesis attributed to trauma in which previous roentgenograms were found to show a normal lumbosacral spine. The fact that unilateral cases exist (in 25 per cent of cases, according to Willis), and the striking uniformity of defects in each

lamina are points against fracture as the etiological agent. The laminae affected are themselves often defectively developed. The frequency of associated congenital defects in many patients in this series would further substantiate a developmental anomaly as the etiological basis.

#### INCIDENCE

Interarticular neural arch defects have been variously reported by different authors as follows: (1) Neugebauer reports arch defects in 5 per cent of spinal columns, (2) Willis, in 4.3 per cent of 748 American spines, in 5.2 per cent of 1,520 human skeletons, and in 6 per cent of cadavers, (3) Shore, in 9.1 per cent of 56 Bantu South African native skeletons; (4) Stewart, in 39 per cent of 187 spinal columns from Eskimos living north of the Yukon, and in 14.7 per cent of 225 spinal columns from Eskimos living in or south of the Yukon, (5) Mitchell, in 3 per cent of European skeletons; and (6) Congdon, in 5 per cent of 200 skeletons of American aborigines.

Bohart, in 1929, examined roentgenographically the spines of 931 employees of the Belt Railway Company in Chicago, in almost 50 per cent of whom spinal variations and anomalies obtained. Three of these individuals had spondylolisthesis. Herndon found 2 cases of spondylolisthesis in treating 941 consecutive cases of back injuries in industrial employees.

During the 4 year period from 1934 to 1937, 2,683 patients were examined at the New York Orthopaedic Dispensary and Hospital who presented evidence of congenital deformity or mechanical instability of the lumbar spine. A further group of 503 patients presented evidence of other conditions involving the lumbar spine. During this 4 year period, 108 patients with spondylolisthesis and 7 patients with spondylolysis were examined, a total of 115 patients. This represents an incidence of 3.5 per cent in the group of 3,301 patients examined because of signs and symptoms referable to the lumbar spine. In comparison with other reported figures this incidence would suggest that interarticular neural arch defects occur in many individuals without producing symptoms.

# SPONDYLOLISTHESIS

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IN THE 27 year period from 1911 to March 1, 1938, more than 210 000 patients have been examined at the New York Orthopaedic Dispensary and Hospital. The diagnostic classification of the case histories of these patients revealed 313 individuals presenting evidence of spondylosthesis or spondylolysis, all confirmed by roentgenographic studies. This paper is a comparative study of the conservative and operative treatment of this group as a whole.

## DEFINITION AND ETIOLOGY

The term, spondylolisthesis implies a failure of union of the laminae to the pedicles together with an associated slipping forward of the body of a vertebra usually in the lumbar region of the spine. Spondylolysis previously termed *prespondylolisthesis*, implies a congenital non union of the laminae without forward displacement of the vertebral body.

The author believes the etiology of the lesion is essentially a congenital developmental defect in the interarticular portion of the involved vertebra. Willis has demonstrated that a lumbar vertebra is formed from 5 centers of ossification, 1 for the body and 2 for each half of the posterior arch. Of the latter 1 anterior center forms the pedicle, including the superior articular facet and 1 posterior center forms the lamina with the inferior articular facet. Rambaud and Renault, in 1864 referred to the formation of the neural arch by union of lateral anterior and posterior centers of ossification. If these lateral centers of ossification fail to unite, a defect results on each side between the superior and inferior articular facets and a separation of the body from the posterior arch.

In spondylolisthesis the lumbar vertebral body becomes narrower and the sacrum broader in the anteroposterior plane due to developmental response to strains. This indicates that the defect has been present for

some considerable time, certainly longer than the period incident to the usual history of any associated trauma with the onset of symptoms. Capener noted that bone often proliferates from the anterior surface of the sacrum beneath the displaced portion of the fifth lumbar vertebra, forming a buttress which tends to prevent further slipping. A study was made of the roentgenograms of 108 consecutive lumbosacral spines, which happened to include 9 cases of spondylolisthesis. In 80 of these patients the body of the fifth lumbar vertebra was broader than the sacrum, or in 74 per cent of the spines studied. A comparable study of roentgenograms of 125 patients with spondylolisthesis revealed the sacrum to be broader than the fifth lumbar vertebral body in 91 cases, or in 73 per cent of the spines studied. The average broadening of the sacrum for the latter 125 cases was 0.08 inch.

A fracture dislocation of the spine resulting from trauma may simulate spondylolisthesis in late clinical symptoms and in roentgenograms. It is well known that severe trauma to the lumbosacral region can occur without spondylolisthesis resulting. In 5 patients in this series each of whom gave a history of severe trauma at the onset of symptoms, roentgenographic evidence points to the trauma as the exciting factor in the origin of the deformity. Three of this group exhibit a fracture dislocation of the spine at the fourth lumbar vertebra and the 2 other patients show fracture dislocation at the fifth lumbar vertebra. One hundred and nine other patients in this study gave a history of definite trauma which was usually associated with the time of the onset of symptoms and varied markedly in degree. No posterior displacement has been observed associated with the lesion of spondylolisthesis. Junghans has described a *reverse spondylolisthesis* in which there is posterior displacement of the vertebral body associated with arthritis deformans at the articular facets but no patient in this

series exhibited this deformity. Posterior displacements of a vertebral body are frequently observed developmentally and as a result of trauma

Five patients in this series presented an increase in the anterior displacement of the affected vertebral body while under observation, varying from one sixteenth to five-eighths inch. It is noteworthy that 2 of these patients developed spondylolisthesis following previous definite roentgenographic evidence of spondylolysis. These patients were all under treatment during the period of observation, and in no case was additional trauma recorded while the patient was being followed. The paucity of cases and the slight degree of increased slipping of the affected vertebra would tend to indicate that there is not a marked tendency for the deformity to increase.

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## PATHOLOGY

In spondylolisthesis the break in the osseous ring is always found between the articular facets, the inferior facets remaining attached to the laminae. Thus the body of the affected vertebra with its superincumbent weight loses bone connection with the spinous and inferior articular processes that anchor the trunk to the pelvis. The defect may be unilateral but is usually bilateral (Fig 1). In the slipping forward of the fifth lumbar vertebra only the anterior portion of the vertebra is affected, there being no real unlocking of the interarticular joints (Fig 2). The soft tissues elongate and undergo pathological changes not unlike the response to strain in unreduced congenital dislocation of the hip where the capsule and muscles are stretched and thickened with weight bearing.

## SYMPTOMS

Pain in the low back was practically the universal chief complaint that was encountered in this series of patients, with considerable variation in the intensity of the pain. However, 13 individuals were entirely free from pain and in 10 instances the deformity was an incidental finding upon examination of the patient for other conditions. Weakness, fatigue or stiffness in the low back as opposed to definite severe pain caused several patients to seek treatment. Low back pain ranging from an occasional ache to constant, severe pain occurred in 35 patients. Thirty-six individuals localized their pain at the hip, 17 in the buttock, and 9 in the coccyx. Radiation of pain down the leg was present in 129 individuals and confined to the distribution of the sciatic nerve in 27 of these patients. Ten individuals suffered pain in the foot down to the toes. Patients suffering from paraplegia associated with spondylolisthesis have been reported in the literature but were not found in this series. Duration of symptoms varied from 12 hours to 30 years. The average duration of symptoms was 30 months.

The clinical picture of the patient suffering from severe spondylolisthesis has been classically described by Turner and Tchirkin with particular attention directed to the lumbar

lordotic hollow, shortened trunk, prominent spinous process of the fifth lumbar vertebra, and fatty skin folds above the iliac crests.

Although several patients in the series presented complete anterior displacement, with the fifth lumbar vertebra rotated on a transverse axis so that its inferior surface rested upon the proximal portion of the anterior surface of the sacrum, the usual clinical picture was less clearly defined. Diminution in the anteroposterior diameter of the pelvic inlet has been especially noted by obstetricians.

In this series, 103 patients presented lumbar muscle spasm. One hundred and thirty-four were tender on pressure over the spinous process of the fifth lumbar vertebra. Increased lumbar lordosis was found in 92 instances although in 30 others there was decreased lumbar lordosis, all confirmed by roentgenograms. In 42 patients the spinous process of the fifth lumbar vertebra and in 5 patients the spinous process of the fourth lumbar vertebra was prominent. In 2 cases there was a kyphosis of the lumbar spine. Spine flexion was limited by pain in 56 individuals. Forty-three were tender on pressure over the sacroiliac region, 8 over the sacrum, and 7 over the coccyx. Thirty-five patients presented a list of the trunk, and 20 others had an associated scoliosis.

There were 175 males and 138 female patients in the series. The youngest patient was 2 years of age, and the oldest 76 years. The average age at first examination was 34 years. The average age at onset of symptoms was 30 years.

## ROENTGENOGRAPHY

Interpretation of the roentgenographic examination of each patient in this series was made by Dr. Albert B. Ferguson, roentgenologist to the New York Orthopedic Dispensary and Hospital. In all cases it was a routine procedure to take a lateral picture of the lumbosacral region, one anteroposterior view and another anteroposterior view at an angle of 45 degrees, the latter film showing the sacrum and sacroiliac joints better and the relationship of the transverse processes of the last lumbar vertebra to the lateral masses of the sacrum.

Spondylolysis or spondylolisthesis was found in the second lumbar vertebra in 3 individuals, in the third lumbar vertebra in 6 patients, in the fourth lumbar vertebra in 35 instances, in the fifth lumbar vertebra in 267 individuals, and in the sixth lumbar vertebra in 2 cases. Complete failure of fusion of the laminae to the pedicles was present in 257 patients. In 37 individuals asymmetry of the articular facets was also present, and increased obliquity of the articular facets was noted in 61 others. Arthritic lipping was found in 40 patients. In 40 instances there was proximity of the spinous processes of the affected vertebrae. Thinning of the intervertebral disc was present in 32 cases. In 156 patients the lumbosacral angle exceeded 40 degrees. Posterior sacral defects were noted in 45 patients.

In 6 patients the lesions of both spondylolisthesis and spondylolysis were found in different vertebrae. There were 6 cases of unilateral spondylolysis in which the neural arch defect was confined to one side, the opposite laminar development being normal.

#### DIFFERENTIAL DIAGNOSIS

Careful physical examination with proper roentgenographic study of the patient are the essential factors in establishing the diagnosis. In spondylolysis and in no other condition is there a characteristic defect in the lamina which is always localized to the interarticular portion of the posterior arch between the superior and inferior facets. In spondylolisthesis there is added a slipping forward of the vertebral body. Frequently there is an associated underdevelopment of the posterior vertebral arch. There is anteroposterior broadening of the sacrum in relation to the vertebral body of the fifth lumbar vertebra, when the lesion is located at the lumbosacral joint.

Fracture-dislocation at the lumbosacral joint is accompanied by either a dislocation of the facets, or fracture of the facets. The laminae remain intact, the facets going forward with the body. There is usually evidence of callus formation at the site of the lesion. There is no evidence of developmental changes in anteroposterior diameter of the sacrum and fifth lumbar vertebral body. There is a separation of the spinous processes.

In Pott's disease an effusion, even though mild, is present. There is bone destruction, cavitating the vertebral body; there is usually a kyphosis in the alignment of the spinous processes; there is no separation of the vertebral body forward from the arch unless there is great destruction, in which case there will be evidence of sequestration.

In Kuemmel's disease there is simple wedging of the vertebral body. No features of spondylolisthesis are present.

In osteomalacia there is wedging of the vertebral body. Often there is expansion of the intervertebral disc. The lesion is almost always multiple and no features of spondylolisthesis are present.

Malignancies do not tend to induce displacement or deformity of the vertebral body. The destruction cavitates the vertebral body and does not represent a pressure loss of substance.

Congenital dislocation of the hips and coxa vara may be ruled out by the condition of the hips in the absence of signs of spondylolisthesis in roentgenograms of the lumbar spine.

Interarticular neural arch defects or luxation of the vertebral body are usually not found in roentgenograms of the lumbosacral spine in those patients whose symptoms follow rupture of the nucleus pulposus of the intervertebral disc or hypertrophy of the ligamentum flavum.

#### OPERATION

By means of the spine fusion operation bony continuity is restored between the lumbar spine and the sacrum. Solid bony fusion precludes further anterior displacement of the affected vertebral body. The operation essentially extends the sacrum in a proximal direction. Fusion of the fifth lumbar vertebra alone to the sacrum, when the spondylolisthesis affects the fifth lumbar vertebra, is insufficient to restore bony continuity. Fusion from the fourth lumbar vertebra to the sacrum has been found practical in cases with spondylolisthesis of the fifth lumbar vertebra, and it is not essential to include the third lumbar vertebra in the fusion area as was done in several instances in this series. The third lumbar vertebra must be included in the



fusion area, however, when the spondylolisthesis is present at the fourth lumbar vertebra

The indication for operation procedures is usually determined by the degree and duration of pain. In other words, when the pain becomes so severe that the sufferer demands relief not obtained by conservative methods of treatment, the operation is definitely indicated. Once the diagnosis has been established and there are no contra indications to operation because of age or physical condition, the patient is advised to undergo the operative treatment. The giving of such advice has caused many patients in this series to seek other forms of treatment elsewhere before conservative methods of treatment, including physiotherapy and local support, could be instituted.

The first spine fusion in this series for spondylolisthesis was done on October 13, 1914, and the first fusion operation for spondylolysis was performed on March 28, 1928. One hundred and ten patients have been treated by the spine fusion operation, performed in each instance according to the technique first described by Dr. Russell A. Hibbs. One hundred and two of these patients had spondylolisthesis and eight had spondylolysis. Occasionally the spinous process of the third lumbar vertebra or bone from the adjacent posterior superior iliac spine has been utilized as a source of additional bone chips for reinforcement. No bone graft or osteoperiosteal graft was used because multiple bone chips are considered preferable for the purposes of fusion. In one individual an osteoperiosteal graft inserted at another hospital had to be removed before fusion could be obtained. The duration of each operation ranged as a rule between one and one and one-half hours. A typical fusion mass is shown 8 months following operation for spondylolisthesis (Fig. 3).

Anterior approach to the lumbosacral region of the spine has been utilized in fusion operations for spondylolisthesis by Burns and by Mercer. Necessity of invading the peritoneal cavity plus possible hemorrhage from the lumbar veins which lie anterior to the lumbosacral area to mention no further technical difficulties are sufficient reasons for hesitancy

in using the anterior approach method in the light of results as obtained by the spine fusion according to the technique of Hibbs performed through the posterior approach. No method has been found to assure reduction of the anterior luxation of the affected vertebra in this series. In several of the patients, plaster jackets were applied under traction in an effort to reduce the deformity, but review of these cases fails to indicate any reduction of the anterior slip of the involved vertebral body.

The treatment following operation consisted of a period of recumbency in bed for 6 to 12 weeks during which time a light steel spinal brace extending from the shoulders to the sacrum is worn. The length of time the patient wears the brace while ambulatory varied between 3 months and 1 year depending upon the type of the individual patient and solidity of the fusion mass as judged from roentgenograms. The optimum period is now deemed to be 12 weeks of recumbency following operation as a minimum, with ambulatory wearing of the spinal brace for at least 6 months following the operation.

In this series there were no operative deaths. There were 3 infections, one of which was due to mixed *Staphylococcus* and *Streptococcus* infection, and 2 due to *Staphylococcus* alone. All 3 infections cleared up after incision and drainage of the operative wound and all 3 patients demonstrated a solid fusion mass in roentgenograms subsequent to operation. In a few instances the meninges were opened unintentionally during operation with no ill results to the patient.

Although 22 or 24 per cent of the 91 patients included in the follow up study of the operated cases developed a failure of fusion or pseudarthrosis, this apparently high incidence of pseudarthrosis is not considered surprising in view of the very severe stresses and strains which beset the lumbar spine and more especially the lumbosacral juncture.

#### FOLLOW UP STUDY

Nineteen patients operated upon because of spondylolisthesis were followed after operation less than 1 year and therefore, are not included in the follow up study. The efficacy



Fig 1 Forty-five degree anteroposterior view showing bilateral interarticular defect in spondylolisthesis of the fifth lumbar vertebra in a male patient 15 years of age



Fig 2 Lateral roentgenogram of spondylolisthesis of the fifth lumbar vertebra present in a female patient 34 years of age

of the spine fusion operation must, therefore, be judged from the results obtained in 83 patients with spondylolisthesis and 8 patients with spondylolysis, a total of 91 patients. One hundred and twelve fusion operations were performed upon these 91 patients, as 14 patients required secondary operations for repair of pseudoarthrosis. The shortest follow-up period included was 1 year. There is 1 patient who has been followed for 19 years. The average follow-up period for the 91 cases is 5 years.

Seventy-four patients, or 81.3 per cent of the cases in this group, were entirely relieved from pain by the operative procedure. Several of these patients have returned to work as laborer, bricklayer, painter, or machinist, which illustrates that it is possible for these individuals to resume former occupations. Thirteen patients, or 14.3 per cent, have been improved by the spine fusion operation, but were not entirely relieved from all low back pain. Several of these individuals complain only of an undue sense of fatigue in the low back area after long hours of work. In 7 of



Fig 3 Lateral view of spine fusion mass extending from the fourth lumbar vertebra to the sacrum. Same patient as shown in Figure 2

the group roentgenographic examination indicates the presence of pseudoarthrosis in the spine fusion mass, but further operative measures have been denied by the patient. No patient in this class is suffering from pain as intense as that present before operation, and all have secured more than 50 per cent improvement in relief of their pre operative pain.

Four patients or 4.4 per cent of the 91 patients in the follow up study, have not been improved by the spine fusion operation. One of these patients showed no fusion present 5 years after the spine fusion operation. At that time a refusion operation was performed in another hospital, following which the patient died with urinary suppression due to a chronic nephritis. In the other 3 patients there was roentgenographic evidence of pseudoarthrosis in the spine fusion area. A refusion operation was therefore indicated, and was performed in another hospital in 1 instance. Permission for refusion has been withheld in the second patient, and is contra indicated in the third patient who suffers from a severe cardiac lesion.

The ability to secure solid bony fusion in the spine fusion mass varies individually due to factors which are obscure at the present time. Ten patients underwent refusion before securing solid bony union. Three other patients had 2 refusion operations performed before solid fusion was present. In 1 other patient it was necessary to perform 3 refusion operations. Co operation of the patient is considered to be of uppermost importance. The best of nursing care with gentleness in turning the patient while in bed, is a prime requisite. A well balanced diet, adequate in vitamins is also thought important. These patients are encouraged to increase their consumption of milk following the spine fusion operation.

#### CONSERVATIVE TREATMENT

Many patients in this series feared and refused operative measures to secure relief from their symptoms, or were considered poor candidates for the spine fusion operation because of advanced age or physical condition. Frequently physiotherapy in the form of local

heat and massage to the lumbosacral region postural exercises to reduce lumbar lordosis, a firm bed, and support to the lumbosacral spine with a belt or corset, will afford symptomatic relief to these patients. Fifty of these individuals have been followed from 1 to 18 years. Thirty one, or 62 per cent of these patients, have had no improvement in their condition from the conservative methods of therapy. Ten or 20 per cent of these individuals, have been relieved somewhat by conservative treatment, and only 9, or 18 per cent, have been entirely relieved from recurrence of their symptoms.

#### SUMMARY

1 Two hundred and seventy one patients with spondylolisthesis and 42 patients with spondylolysis, a total of 313 cases, are reported.

2 A follow up study of 91 patients who underwent spine fusion operations, after the technique of Hibbs, between October 13, 1914, and February 12, 1937, is reported.

3 There were 175 male and 138 female patients in the series.

4 The age at the time of examination varied between 2 and 76 years of age, the average being 34 years.

5 There was no operative death in the series.

6 There were 22 patients, or 24 per cent, who developed failure of fusion or pseudoarthrosis many of whom were relieved by repair of the pseudoarthrosis at a second operation.

7 Thirty-one patients or 62 per cent of 50 individuals studied failed to obtain relief from conservative methods of treatment.

8 Seventy four patients or 81 per cent of 91 individuals receiving the operative treatment were completely relieved of symptoms.

9 In spondylolisthesis or spondylolysis a spine fusion operation is considered to be the method of treatment best calculated to give permanent relief from symptoms and to be fully justified by the results obtained in this series of cases.

10 Evidence is presented which tends to confirm the theory that the lesion in spondylolisthesis and spondylolysis is essentially a

congenital developmental defect in the inter-articular portion of the laminae of the involved vertebra rather than the result of trauma

# BIBLIOGRAPHY

- 1 BOHART, W H Anatomic variations and anomalies of the spine J Am M Ass, 1929, 92 698-701
- 2 BURNS, B H An operation for spondylolisthesis Lancet, 1933, 224 1233
- 3 CAPEYER, NORMAN Spondylolisthesis Brit J Surg, 1932, 19 374-386
- 4 CONGDON, R T Spondylolisthesis and vertebral anomalies in skeletons of American aborigines, with clinical notes on spondylolisthesis J Bone & Joint Surg, 1932, 14 511-524
- 5 FITCH, R R Subluxation of the lumbosacral joint as a cause of paraplegia, report of a case, recovery after manipulation Am J Orthop Surg, 1913, 10 587-602
- 6 HERNDON, R F Back injuries in industrial employees J Bone & Joint Surg, 1927, 9 234-269
- 7 HIBBS, RUSSELL A An operation for progressive spinal deformities New York M J, 1911, 93 1013
- 8 JENKINS, JAMES A Spondylolisthesis Brit J Surg, 1936, 24 85-85
- 9 JUNGHAUS, H Die Spondylolisthesis im Rontgenbild Fortschr a d Geb d Roentgenstrahlen, 1930, 41 239-245
- 10 Idem Spondylolisthesen ohne Spalt im Zwischengelenk Arch f orthop u Unfall-Chir, 1930, 29 118-127
- 11 LANE, W A Case of spondylolisthesis associated with progressive paraplegia, laminectomy Lancet, 1893, 1 991-992
- 12 MERCER, WALTER Orthopaedic Surgery Baltimore William Wood & Co, 1936
- 13 Idem Spondylolisthesis Edinburgh M J, 1936, 43 545
- 14 MITCHELL, G A G Radiographic appearances in spondylolisthesis Brit J Radiol, 1933, 6 513-529
- 15 Idem The lumbosacral juncture J Bone & Joint Surg, 1934, 16 233-254
- 16 NEUGEBAUER, F L Ein Neuer Beitrag zur Casuistik und Aetiologie der Spondylolisthesis Arch f Gynaek, 1884, 22 347-407
- 17 RAMBAUD, A, and RENAULT, Ch Origine et Developement des Os Chamerot, Paris, 1864
- 18 SHORE, L R A report on a specimen of spondylolisthesis found in the skeleton of a Bantu native of South Africa, with further specimens illustrating anomalous mode of development of lower lumbar vertebrae Brit J Surg, 1929, 16 431-439
- 19 STEWART, T D Incidence of separate neural arch in lumbar vertebrae of Eskimos Am J Phys Anthropology, 1931, 16 51-62
- 20 Idem Spondylolisthesis without separate neural arch J Bone & Joint Surg, 1935, 17 640-648
- 21 Idem The vertebral column of the Eskimo Am J Phys Anthropology, 1932, 17 123-136
- 22 TURNER, HENRY, and TCHIRKIN, NIKOLAS Spondylolisthesis J Bone & Joint Surg, 1925, 7 763-786
- 23 WILLIS, T A Backache from vertebral anomaly Surg, Gynec & Obst, 1924, 38 658-665
- 24 Idem Low back pain J Bone & Joint Surg, 1937, 19 745-748
- 25 Idem Lumbosacral vertebral column in man, its stability of form and function Am J Anat, 1923, 32 95-123
- 26 Idem The separate neural arch J Bone & Joint Surg, 1931, 13 709-721

# CLINICAL SURGERY

FROM THE KING'S COLLEGE HOSPITAL

## TRACHEOTOMY

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**T**RACHEOTOMY consists in making an opening into the trachea below the larynx and to be successful the opening must be below the obstruction that makes the operation necessary and it must be maintained free from subsequent obstruction.

The operation is simple provided that it can be done without undue haste and in good surgical surroundings. Moreover, any possible dangers are easily avoided by obeying the few well defined rules that will be described later, and no complications are likely to follow a good operation that receives proper attention afterward. It should be the aim of every doctor who has to deal with a case of laryngeal obstruction requiring tracheotomy to plan the operation so that it may be carried out in a deliberate, orderly and unhurried manner. If however, laryngeal obstruction develops rapidly, or if medical advice is not sought until the obstruction is in an advanced stage a hurried operation in unfavorable surroundings may be essential if life is to be saved.

It is the purpose of this article to describe the deliberate operation step by step, not only because this is the method of choice but also because a thorough appreciation of the planned operation will aid the surgeon when circumstances demand the hurried operation as a life saving measure.

### INDICATIONS

Tracheotomy is required when obstruction at or about the larynx so diminishes the respiratory exchange that it is insufficient for the needs of the body when at rest. Tracheotomy may also be required as a preliminary stage in certain operations on the air passages. Finally it has been recommended recently in certain cases of tracheo-bronchial suppuration.

Laryngeal obstruction may be produced by a variety of causes but as the most urgent consideration is to relieve the condition it will be better to consider in detail the prominent features of laryngeal obstruction rather than to enumerate a list of conditions that may cause it.

The picture produced by laryngeal obstruction depends largely upon the time which such an obstruction takes to develop. When the onset is sudden and the rate of increase fast, the symptoms, signs and the remedy required are only too obvious, even to the lay eye. When the obstruction increases slowly the significance of the panorama that gradually unfolds itself may not always be appreciated in the early stages or if it is surgical relief may be withheld in the vain hope of a spontaneous cure.

**Respiratory system.** Audible respiration is the most obvious sign of laryngeal obstruction and is present in every case. The pitch and amplitude of the sound may depend to a certain extent upon the age and sex of the patient and upon the degree of obstruction. The timbre of the sound however, is constant in all cases. It can be produced by anyone at will by making a forced inspiration with the glottis nearly closed. It is usually described as *crowing* and must be distinguished from obstruction in the lower part of the tracheo-bronchial tree in which the noise is a *whistle* usually more noticeable on expiration. This is rather an important point because the writer has been asked on more than one occasion to perform a tracheotomy on a patient with obstruction in the lower part of the trachea. Had the referring physician trained his ear to recognize the difference between a crow and a wheeze he would have realized that the obstruction could not be relieved by tracheotomy.

At the onset of laryngeal obstruction audible respiration may not be noticed when the breathing is quiet and shallow. Anything that may increase the rate or extent of the respiratory exchange will tend to initiate or augment audible respiration. This accounts for the phenomenon not infrequently seen in children where a fit of struggling for breath and rapid and exaggerated respiratory efforts are succeeded by exhaustion in which the quiet and shallow respiratory movements cause the audible respiration to disappear. In brief every case of audible respiration should

be considered as a potential candidate for tracheotomy. For the large majority of these cases tracheotomy will not be necessary, but an attitude of preparedness will go far to avoid the tragedies resulting from the neglect of one of nature's greatest danger signals.

The bringing into action of the accessory muscles of respiration in conjunction with other signs indicate laryngeal obstruction. In this connection it is worth while mentioning the significance of the alternate periods of quiet sleeping and choking fits with waking that are so characteristic of increasing obstruction. While the patient is conscious the voluntary or accessory muscles of respiration are brought into use, but as the patient falls asleep the voluntary muscles stop working. This may not be noticed for some seconds or minutes, but gradually diminished air entry calls for deeper respiration and this causes choking and the patient awakes.

The soft tissues which clothe the thoracic cage may be indrawn on each inspiration. This can be seen at the suprasternal notch, in the supraclavicular region, and between the ribs. It should always be sought for, and the degree and extent of the indrawing is a rough index of the severity of the laryngeal obstruction. On inspiration the rush of air acts on the soft tissues surrounding the upper margins of the larynx and draws them in, thus further narrowing the already restricted airway. It is this mechanism which accounts for the increased distress that is noticed with forcible inspiration and is such a marked feature of the complaint in children. When the laryngeal obstruction is very gradual in its onset and extremely slow in its progress, such as in the case of a neoplasm, the patient learns to economize in respiratory movements and may reach a very high degree of tolerance to the obstruction, so that life is possible with an airway that would have been totally inadequate if the onset of the condition had been rapid.

In the terminal stages of laryngeal obstruction the respiratory mechanism is likely to show signs of exhaustion, and the respiratory movements become more gentle until at last they quietly cease forever.

*Cardiovascular system.* In advanced stages of respiratory obstruction diminished oxygenation of the blood will result in cyanosis, and the degree in which this is reflected in the skin depends upon several factors. In those cases in which there is a good peripheral circulation and a normally fresh color, cyanosis will be obvious. In the normally pale, or in those in whom the heart is already enfeebled by disease, cyanosis may be absent

and there may only be increasing pallor with a slightly leaden or mauve tinge to indicate the true state of affairs. This is especially noticeable in the most dangerous type of case under consideration, diphtheritic laryngeal obstruction in childhood in which the already enfeebled heart is handicapped by a tremendous increase in work. This results in pallor due to the poor peripheral circulation and such pallor may only give way to cyanosis in the ultimate stages of the complaint. In other words, cyanosis may be obvious only as a terminal event and should not be waited for before advising tracheotomy. What is not generally realized is the tremendous increase in work that the heart is called upon to do in cases of respiratory obstruction. In small children, in the presence of audible respiration, it is very strongly felt that one of the most urgent reasons for tracheotomy is an increasing pulse rate and signs of dilatation of the right side of the heart.

#### PRE-OPERATIVE PREPARATION

Tracheotomy does not call for any special pre-operative measures apart from ensuring that the necessary equipment is at hand and in good working order. This is a very necessary pre-operative precaution because tracheotomy is a relatively infrequent operation, and unless periodically overhauled the instruments have a way of getting mislaid. Whenever time will permit, steps should be taken to provide proper postoperative care, because the ultimate success of the operation depends so much upon this.

The method that will be described is employed in the clinic at King's College Hospital whenever the condition of the patient will permit. The operation need not take more than 10 minutes and is always employed when the patient has sufficient airway to enable him to be removed to a properly equipped operating theater. Sometimes the need for relief of laryngeal obstruction is so urgent that more rapid methods must be employed, possibly in unfavorable surroundings without all the equipment and assistance that may seem necessary. Then the method employed to relieve the obstruction will depend upon the resources available and no definite rule can be laid down as to exact procedure. If, however, the cardinal features of the more deliberate operation can be committed to memory, the undoubted difficulties of the life saving emergency tracheotomy will be minimized. The strain of a hurried, and of necessity unsurgical, operation is so great both on the patient and the surgeon that no effort should be spared to bring a patient to operation in time to avoid this.



Fig. 1. A folded towel which is placed under the shoulder extends the neck so that the trachea is brought nearer to the surface.



Fig. 2. The field of operation showing the principal landmarks: the thyroid cartilage above the suprasternal notch below and the sternomastoid muscles on either side.

**Anesthetic.** Any form of general anesthetic, however skilfully administered, is bound to aggravate laryngeal obstruction. The possible advantage of unconsciousness to the patient is far outweighed by the danger of increasing any pre-existing obstruction to the airway, and for this reason a general anesthetic cannot be recommended.

Subcutaneous infiltration of the operative areas with 1 per cent novocain not only renders the operation painless but also diminishes the tendency to bleeding. This form of anesthesia should always be employed when time will allow. Urgent dyspnea or infection in the tissues overlying the trachea may require operation without any form of anesthesia at all.

**Position.** The patient should be lying on his back with a sandbag or folded towel underneath

the shoulders so as to extend the neck and thus bring the trachea nearer to the surface. The head should be extended on the neck and it must be kept strictly in the midline so that the nose, chin and suprasternal notch are in one line. Any deviation from this midline position will alter the normal relationships of the trachea and add to the difficulties of the operation. This is so important that an assistant can be well employed in steadying the head and seeing that it is kept in the midline. It sometimes happens that the prone position with extended neck makes a partial laryngeal obstruction complete. Then in order to operate in an orderly unhurried manner it may be necessary to work with the patient sitting up. This is not easy and should be considered only in the non-urgent cases of obstruction where speed is not essential.

**Infiltration.** The skin and subcutaneous tissues in the midline of the neck are infiltrated with 1 per cent novocain from the thyroid cartilage to the suprasternal notch. A band of infiltration one inch wide is required and can usually be obtained with 20 or 30 cubic centimeters of fluid. As much as 100 cubic centimeters may be used without any danger.

#### OPERATION

**Incision.** The surgeon stands on the right side of the patient and the principal assistant on the left. The mobile larynx and skin are fixed by the thumb and middle finger of the left hand. This is of special importance in children in whom the larynx is very mobile and is one of the essential steps of the emergency operation. The incision should extend vertically downward from the cricoid cartilage for at least 3 inches and must be



Fig. 3. The incision has exposed the pretracheal muscles and the line of separation between the muscles. The two lobes can be seen in the center.

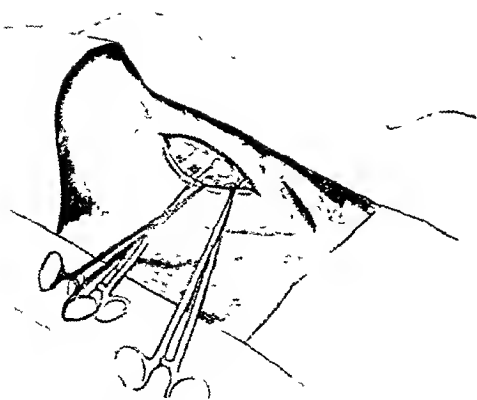


Fig 4 The trachea has been exposed, and the isthmus of the thyroid gland is shown covering the third and fourth tracheal rings

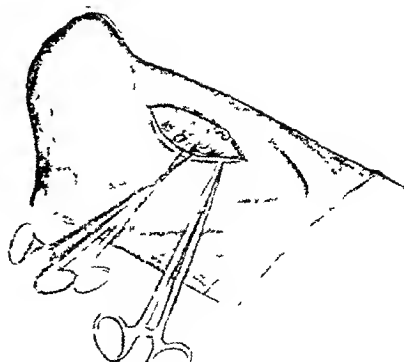


Fig 5 The unimportant thyroid isthmus has been divided between ligatures so as to give better exposure of the trachea

strictly in the midline. The only exception to this rule is when the tracheotomy is required as a preliminary to a pharyngeal or laryngeal operation. In such a case an oblique or transverse incision 1 or 2 fingers' breadth below the cricoid cartilage may be used.

The incision should extend through the skin and down to the deep cervical fascia in its whole length. Any bleeding points are secured by artery forceps that may conveniently be curved so that they lie flat on the neck and act or be used as retractors. In the hurried operation the incision must go deeper than this, preferably down to the trachea, and bleeding is to be ignored.

**Exposure of the trachea** The deep fascia is incised, again strictly in the midline, when the division between the 2 sets of pretracheal muscles may be seen. Careful separation is important here, especially in children, because it is very easy to deviate from the midline, especially to the left. Loose cellular tissue will be found here, particularly in the lower part of the wound, and then another sheet of fascia comes into view. At this stage the position of the trachea may be confirmed by palpation with the left index finger. In the emergency operation directly after the deep incision the left index finger will be employed in feeling for the tracheal rings and continuing any essential blunt dissection. It must be remembered, however, that in very young children the cartilaginous rings of the trachea may be deceptively soft. Under this second sheet of fascia lies the trachea in the uppermost part of the wound. A little farther down is the isthmus of the thyroid gland. The isthmus usually lies over the third and fourth tracheal rings and may easily be retracted downward. If unusually high or diffi-

cult to retract, the isthmus should be divided between forceps without hesitation, as it is only of anatomical importance. If special angular clamps are used on the isthmus they may, after it has been divided, be rotated outward, thus bringing the trachea more to the surface. Incision of the investing tracheal fascia reveals the tracheal rings.

**Intratracheal injection** At this stage, if time permits, it will be advantageous to insert the needle of a hypodermic syringe charged with 10 per cent cocaine between 2 tracheal rings and to inject a few millimeters of the cocaine solution into the tracheal lumen. This serves to lessen the spasm of coughing that would otherwise occur when the trachea is opened, and makes for what its originator, Sir St Clair Thomson, describes as tranquil tracheotomy.



Fig 6 A disk has been cut out of the anterior tracheal wall just sufficiently large to admit the tracheotomy cannula



**Hemostasis** At this stage all bleeding points should be ligatured and artery forceps removed. It is important not to trust to the temporary pressure of the artery forceps to arrest hemorrhage, because it not infrequently happens that unligatured vessels may start to bleed after the vasoconstrictor effect of the local anesthetic has worn off. In the hurried operation both this and the preceding stages will be omitted and bleeding can be dealt with after the trachea is opened.

**Opening the trachea** The site of election is through the third and fourth tracheal rings. In no circumstances should the cricoid cartilage or first ring of the trachea be cut across for fear of subsequent laryngeal stenosis. Insufficient attention is paid to this essential point in many of the descriptions appearing in textbooks and possibly only those who have the unenviable task of trying to cure laryngeal stenosis realize how important it is to maintain the integrity of the cricoid cartilage and uppermost tracheal ring.

In small children in whom the trachea is very mobile it may be advisable to steady the trachea by inserting a sharp hook into or just below the cricoid cartilage and having this held by an assistant. At this stage the end piece of a suction apparatus should be held near the trachea so the tracheal opening may be kept free from secretion and blood prevented from entering the trachea.

With a fine bladed scalpel a short transverse incision is made to one side of the center of the front wall of the trachea between the third and fourth tracheal rings. Into this incision is inserted one blade of a pair of fine toothed forceps. The tracheal wall is grasped by the forceps and one blade of a pair of fine fully curved scissors is inserted and a small disc of the anterior tracheal wall cut away. This disc should be the same size as the diameter of the tracheotomy tube so that when the tube is in position it will fit tightly and prevent any escape of tracheal secretion or air into the wound. During this maneuver care must be taken so that the posterior tracheal wall is not injured because the violent expiratory effects that may accompany the opening of the trachea especially if cocaine has not been previously injected will bring the posterior wall forward so that it may almost bulge into the tracheal opening. Even worse than this would be perforation of the posterior tracheal wall and injury of the esophagus. This might happen if the scalpel were indiscriminately plunged into the trachea. The possibility of this occurring can be prevented by so holding the scalpel that only a quarter of an inch projects beyond the end of the index finger.

An alternative method is to incise vertically the third and fourth tracheal rings in the midline and then to insert a pair of dilating forceps. This will be the procedure in hurried cases but if speed is not essential the careful removal of a small disk of tracheal wall is preferred. It makes introduction and removal of the cannula easier and in the event of the outer cannula being accidentally displaced retraction of the edges of the wound will enable the patient to breathe until skilled help is available to replace the tube.

**Insertion of the tracheotomy tube** The tracheotomy tube is now inserted with its pilot which is withdrawn when the tube is in position and the inner tube is inserted. Prior to this one fourth inch linen tape has been threaded on to the wings of the tube. The inner 2 inches of each tape is guarded by a piece of rubber tubing which prevents the tape from cutting into the sides of the wound. In emergency cases artificial respiration and stimulants may be required at this stage. The bleeding also that had been ignored previously, will not have to be stopped although the opening of the trachea will have done much to lessen it.

**Dressing** While the tube is held in position by an assistant the wound is lightly packed with 2 inch ribbon gauze impregnated with iodoform. Under no circumstances should the part of the wound below the cannula be sutured for fear of surgical emphysema or spreading sepsis. Two squares of gauze are placed over the dressing one above and one below the tube and the tapes are tied around the neck over this.

The skin below the wound may be smeared with soft paraffin to prevent irritation from secretion. Over all this is placed a veil of oiled silk with a hole in the center through which the tube projects. This helps to keep the dressing from being unduly soiled by tracheal secretion.

**Asapnia** Before the patient leaves the theater a final inspection should be made to ensure that there are no bleeding points and a note should be made of the respiration. Numerous fatalities have been recorded from time to time that occurred shortly after the trachea was opened. These have often been in cases of long standing laryngeal obstruction and it has been shown by X-rays that they are due to asapnia. During the period of laryngeal obstruction there has been a steady increase in the carbon dioxide content of the alveolar air and also in the carbon dioxide content of the blood. Sudden removal of the obstruction results in this excess of carbon dioxide suddenly being reduced. The respiratory center has been accustomed to an increased carbon

dioxide stimulus, and when this is suddenly removed it refuses to respond. Unless carbon dioxide is available the patient may die from apapnia. Therefore, provision should be made in the operating theater and at the patient's bedside for a carbon dioxide-oxygen mixture to be available if required.

#### POSTOPERATIVE CARE

The relief of laryngeal obstruction by the provision of an alternative airway does not mean that medical supervision can be relaxed. On the contrary, it initiates an entirely fresh set of therapeutic problems that require careful and constant attention if a successful outcome is to be attained. The problems that are the immediate concern of those responsible for the after-care are (1) the maintenance of a free airway, (2) the accommodation of the patient to the altered conditions of his respiratory mechanism, and (3) the neutralizing of the ill effects produced by prolonged obstruction on the lower respiratory tract. In order that these problems may receive the attention they require, constant nursing supervision is necessary and certain special equipment must be available at the bedside. It will be convenient here to give separate descriptions of the more important factors concerned.

**Bedside equipment.** It has already been mentioned that a cylinder of carbon dioxide and oxygen should be at hand. A trolley should contain sterile duplicate cannulae, retractors, a tracheal dilator, inner tubes, lotion, cleaning material for removal of secretion from inner tubes before boiling, a suction apparatus with two or more fine rubber catheters ready to be attached, and sterile dressings. These are the essentials that should be at the bedside of every tracheotomy patient.

**Free airway.** Constant attention is necessary for this. Secretion must be removed from the tracheal tube either by mopping or by suction. Any audible respiration means that some part of the respiratory tract is obstructed, and it may be helpful to pass a catheter down into the trachea and connect it to the suction apparatus. This may save the patient much laborious coughing. It will probably be necessary to remove the inner tube frequently for cleaning, and this should be instantly replaced by a spare inner tube, the soiled one being cleaned before boiling. It cannot be too firmly impressed upon the nurse in charge of the case that her main duty is to see that instant attention be given to any signs of obstruction, i.e., audible respiration or rapidly increased respiratory movements. Should the outer cannula become dislodged, she should

remove all dressings, retract the wound edges, and wait for skilled help if she cannot easily replace the outer cannula herself. Central heating may reduce the humidity of the air, so that steps should be taken to remedy this. Care must be taken, however, not to overdo this, as it is felt that overuse of the steam kettle may do as much harm as it does good.

**Accommodation to altered mechanism.** It is always advisable to protect the patient from rapid changes of the temperature of the inspired air by means of a tent or screen around the head of the bed. One of the most important reasons for constant supervision during the first few hours after the operation is that the patient is deprived of his voice and is unable to call for assistance. Some slight difficulty in swallowing may sometimes be experienced, but encouragement with sips of water will usually overcome this. Excessive coughing may cause some distress, as the alteration of the normal coughing mechanism may make the bringing up of tenacious secretion a laborious matter. This can to a certain extent be overcome by using a suction apparatus to aspirate tenacious secretion from the trachea.

**Lower respiratory tract.** The removal of retained secretion can be assisted by the suction pump, in the way just described. At this stage it is wiser not to give any sedative that might in any way obtund the cough reflex. In order to assist expansion of the lungs the patient should be sat upright and encouraged to move from side to side so as to prevent stagnation at the bases of the lungs. An additional help in this direction will be the administration of the carbon dioxide-oxygen mixture for a few minutes every hour. When the secretion is very thick and tenacious the administration of alkalis may help to loosen it. Cases of laryngotracheobronchitis in which there may be a tendency to form crusts within the trachea and bronchi must be watched carefully. Increased respiration rate, distress, and on examination of the chest little or no expansion and air entry indicate blocking of a main bronchus with a plug. This calls for bronchoscopy which in severe cases may have to be repeated frequently.

**Dressing.** This will require frequent changing during the first day or two. The gauze squares should be changed whenever they are soiled, while the iodoform gauze packing in the wound should be changed at least once, if not twice, every 24 hours. It is rarely necessary to change the gauze more often than this and if the surrounding skin is kept protected by sterile soft paraffin no irrita-

tion from being constantly bathed in secretion should occur

At every change of dressing the opportunity should be taken to examine the wound for any suggestion of spreading sepsis or surgical emphysema. All assistants should be warned not to use gauze with loose threads, and never to use wool, because these can easily be inspired into the tracheobronchial tree. The same thing applies to blankets which should not be allowed near the tracheotomy tube for fear that fluff from them may be inspired.

*General Treatment* will naturally be directed toward the cure of the laryngeal obstruction but is beyond the scope of this article. Adequate nourishment is essential and a large fluid intake must be encouraged.

When the cardiovascular system has been subjected to strain, small but regular doses of brandy should be given or more severe cases may require some form of digitalis or one of the more powerful cardiac stimulants such as coramine.

As soon as the general condition of the patient will permit, he should be encouraged to move from his bed. This will help to exercise the lungs.

*Decannulation* This must be a gradual process. As soon as the patient can breathe comfortably with a finger over the tracheotomy tube it should be half corked. When the patient can sleep comfortably with this, the half cork can be replaced by a complete cork. Comfortable sleep with the tube completely corked is the indication for decannulation.

The return to laryngeal breathing may, at first, cause slight dyspnea especially in children. If decannulation is too rapid the dyspnea may result in panic, exaggerated respiratory efforts and an increase in the dyspnea possibly sufficient to call for re-cannulation. Once this has happened the child will lose confidence, and further decannulation may be quite difficult.

*Re-cannulation* This small maneuver has been the cause of so much trouble that it deserves a paragraph to itself. During the first few days after a tracheotomy it is not as a rule necessary to change the outer tube. Should it become necessary it must be done by the surgeon or a skilled assistant.

It is in the cases that have been decannulated too soon that the chief difficulties arise. It may be some hours after decannulation before the necessity for reinserting a tube is apparent. Unless a disk had been cut from the trachea at the time of operation this may be difficult. In any case it should not be attempted without a

good light, dilating forceps and, if available, a suction pump. It will simplify matters if the wound is packed for a few moments with gauze wrung out of 2½ per cent cocaine. This procedure is given special mention because the writer has found that the re introduction of a tracheotomy tube some time after it had been removed has often caused considerable trouble especially to those who approach the problem overconfident and not prepared.

#### SUMMARY

1 Tracheotomy is required to relieve increasing laryngeal obstruction and should not be postponed until the urgency of the symptoms demand a hurried operation.

2 General anesthesia increases the danger of the operation. Local infiltration renders the operation painless and reduces bleeding.

3 The midline position, a midline incision, and midline dissection will expose the trachea and avoid other important structures. Deviation from this midline rule is the commonest cause of operative difficulties.

4 The trachea must never be incised above the second ring but preferably through the third and fourth. This will avoid the possibility of subsequent laryngeal stenosis, a permanent tube, and loss of voice for life.

5 The intratracheal injection of a few millimeters of cocaine and the excision of a disk of tracheal wall instead of the usual vertical slit are modifications of the traditional technique that make the operation more tranquil and the after treatment more simple.

6 Carbon dioxide should be at hand both in the operating theater and at the bedside in case apnoea should develop. This applies especially to cases of long standing laryngeal obstruction.

7 After care demands constant nursing attention and is directed toward keeping the airway clear, adjusting the respiratory mechanism to altered conditions and combating the effects of laryngeal obstruction on the lower respiratory tract.

8 Decannulation should be gradual and should not be attempted until the patient can sleep comfortably with the tube completely corked.

#### REFERENCES

- 1 WELLS & E. Hunterian Lecture. *Lancet* 1935 Sept 19.
- 2 THOMSON ST CLAIR. *Brit M J* 1919 Oct 11 40.
- 3 THOMSON ST CLAIR and WELLS & E. Diseases of the Nose and Throat. Pp 868-885. London: Cassell & Co. 1931.

# A NEW ASEPTIC DOUBLE-VALVED TUBOGASTROSTOMY

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THE writer introduces a new, simple, and improved method of gastrostomy which is accomplished by a technique that is aseptic throughout.<sup>1</sup> This technique was developed to replace the long and complicated procedures employed today, in which excessive clamping, ligating, cutting, and sewing as well as exposure of the peritoneal cavity to contaminating substances from the gastric content, are objectionable features

## STAGES IN THE EVOLUTION OF GASTROSTOMY

Here a few remarks may be devoted to those stages in the evolution of gastrostomy which lead to the writer's new step. In 1893, Ssabanejew devised a method of gastrostomy in which a cone of stomach was formed by traction upward with an Allis forceps and brought out to the exterior. A second smaller incision was then made nearby through the skin and subcutaneous layer, and the cone carried to it by tunneling through the subcutaneous tissue between the 2 incisions. The apex of the cone after being brought through the second skin incision and attached to its edges, is then opened.

In 1896, Senn described a circular valve method. Purse-string sutures were placed at the base of a cone of stomach wall to fix it in place. An incision was then made into the apex of the conical structure, its free edges inverted, and the resulting fold fixed by sewing its rim, thereby creating a circular valve projecting inward toward the lumen of the stomach.

In 1896, Fontan described a valvular gastrostomy which he produced by elevating a conical diverticulum from the stomach by traction with a forceps, fixing its crown to the abdominal incision, invaginating the apex, and puncturing it. It is seen that it resembles the method devised independently by Senn in the same year.

In 1913, Janeway and Depage, working independently of each other, developed a flap from the anterior wall of the stomach, consisting of all

layers, which was converted into a tube, lined with gastric mucosa, one end of this tube representing the opening into the stomach, and the other end the mouth to the exterior. Depage acknowledged Janeway's work, but it is established that priority really belongs to Depage. This method of gastrostomy proved to be inefficient because of the absence of a valvular structure.

In 1929, Spivack greatly advanced the surgery of gastrostomy by combining the tube formation of Depage and Janeway and his own method of forming a valve by invaginating all layers of the stomach wall, thereby evolving a very useful and efficient tubovalvular gastrostomy. Later McNealy and Thorek contributed to Spivack's operation by attempting to seal off possible points of leakage with omentum and falciform ligament.

## DOUBLE-VALVED TUBOGASTROSTOMY

The great mortality rate following present day methods of gastrostomy is readily explained. Patients who require gastrostomy are those afflicted with esophageal obstruction of a benign or malignant nature. Pathological conditions of this sort weaken the patient to such an extent that by the time an operation is advised and accepted, marked emaciation has already set in, primarily because of the prolonged period of starvation. Obviously, such persons, who in most instances are past middle age, cannot tolerate any abdominal operation of long duration. The contamination of the peritoneum and the severe shock of surgical manipulation weaken the subject, so that death is a common sequel. It is estimated from the writer's gastrostomies on a series of dogs and on human patients that the duration of his method is diminished from approximately 1 to 1½ hours, which is the time required for the present day improved, but more intricate, gastrostomy, to about 20 to 30 minutes, thereby greatly reducing the mortality rate.

The method here described furnishes a double valve of excellent function and in the cases in which it was tried has remained competent throughout the period of observation that has extended over months. Through a left upper paramedian incision the stomach is exposed, and as illustrated in Figure 1, A, the anterior wall of the stomach is grasped with an Allis forceps at

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<sup>1</sup> The technique herein described was developed and perfected in the Department of Anatomy of the University of Illinois, College of Medicine, with the aid of Dr. Otto F. Kampmeier, professor of anatomy and head of the department. To him as well as to Dr. Ingve Joranson, Dr. W. H. Cole, Dr. M. Davison, and Dr. L. Aries the writer is greatly indebted for their invaluable help.



Fig. 1 A Formation of a cone shaped diverticulum from the anterior wall of stomach by traction B Fixation of the formed diverticulum by a basal purse string suture C Insertion of the third purse string suture approximately midway between the basal sutures and the apex of the diverticulum

the most mobile point, which is usually midway between the fundus and the pyloric antrum and equidistant from the greater and lesser curvatures. With the application of traction at this point a portion of the anterior wall is converted into a cone shaped diverticulum. A purse string suture of braided silk is then introduced into the

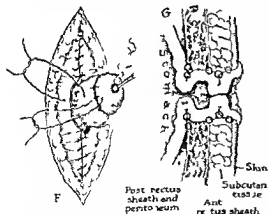


Fig. 2 D Anchoring of the anterior stomach wall to the peritoneum and posterior rectus sheath by means of the desired over-and-over seromuscular stitch E The diverticulum protruding through the opening allowed during the closure of the peritoneum and posterior rectus sheath. More interrupted silk sutures are shown anchoring the lateral sides of the base of the diverticulum to the peritoneum.

seromuscular layer at the base of the diverticulum (Fig. 1, B), and with each stitch the tissue at the base is puckered until upon completion of this purse string suture, the lumen at the base as been almost but not completely constricted. A second purse string suture is then applied in the same fashion as the first about  $\frac{1}{4}$  inch proximal to the first suture. The ends of these 2 sutures are employed for traction when the Allis forceps at the apex is removed. A third purse string suture is then introduced around the diverticulum midway between the apex and base to create a second valve more peripherally placed. Both valves are then reinforced by applying interrupted Lembert stitches of braided silk in the seromuscular layer at right angles to the purse string suture (Figs. 1, C, D, E). At this point the diverticulum, which has been constricted at two levels, usually presents a cyanotic hue but in spite of the disturbance of circulation thus produced no sloughing was noted in a series of 20 experimental animals. Traction on the diverticulum is still kept upward by the assistant. Interrupted seromuscular sutures are inserted in the anterior wall of the stomach at points superior, inferior and lateral to the base of the tubal projection in order to fix the stomach wall to the peritoneum and to the posterior rectus sheath. It is very important that the sutures be embedded repeatedly in the seromuscular layer of the stomach wall before they are tied, since a single stitch may tear through the seromuscular layer. The

Fig. 3 F Two untied sutures shown the lower one representing the suture that attaches the tube to the anterior rectus sheath and the upper one the suture employed further to anchor the tube to the subcutaneous tissue. The cautery applied to the apex is the final step of the operative procedure. G Diagrammatic cross section illustrating the arrangement of the initial or basal valve to the more peripheral valve. The circles represent suture ties employed throughout the operative procedure.

tube itself is attached to the anterior rectus sheath and subcutaneous tissue as the various layers are reconstructed

An opening into the apex of the tube by means of cautery may be made at any time from the first to the seventh day after the completion of the operation. It was found more desirable to delay the opening until near the seventh day, depending upon the patient's ability to swallow liquids, since a greater time is allotted for adhesions to form without any disturbance from external sources. This step is the culmination of an operative procedure which was achieved with entire asepsis, that is, without opening the stomach in the presence of peritoneal exposure, and without clamping, ligating, or cutting.

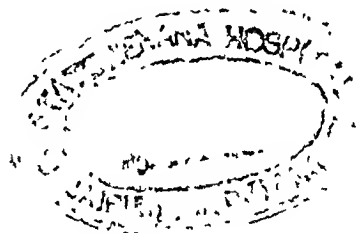
In G of Figure 3 a diagrammatic cross-section illustrates the arrangement of the initial or basal valve to the more peripheral valve. The circles therein represent suture ties, at points previously referred to, in anchoring the stomach and tube to the various abdominal layers.

By employing a technique similar to that described, an aseptic tubovalvular cystostomy is made possible.

The writer, in working out the details of the operation, recognized some modifications in technique which may or may not be advisable in particular cases. For example, in certain cases in which ample mobilization and additional stomach wall is required to establish the tubovalvular formation, partial detachment of the hepatogastric, or of the gastrocolic ligaments is undertaken.

#### BIBLIOGRAPHY

- 1 DEPAGE, A. Nouveau procédé pour la gastrostomie. *J de chir et ann Soc belge de chir*, 1901, 1 715-718
- 2 FONTAN. Sur une nouvelle operation de gastrostomie. *Semaine méd*, 1896, 16 423
- 3 JANEWAY, H. H. Eine neue Gastrostomiemethode. *Muenchen med Wchnschr*, 1913, 60 1705-1707
- 4 SENN, E. J. Gastrostomy by circular valve method. *J Am M Ass*, 1896, 27 1142-1145
- 5 SPIVACK, JULIUS L. Eine neue Methode der Gastrostomie. *Beitr z klin Chir*, 1929, 147 308-318
- 6 Idem. Utilization of posterior wall of stomach in cases of contracted stomach. *Clin Med & Surg*, 1933, 40 212-213
- 7 SSABANEJEW, J. F. A new method of gastrostomy. Report to Odessa Medical Society, Sept 15, 1890, *Zentralbl f Chir*, 1893, 20 862
- 8 THOREK, M. Tubo-valvular gastrostomy. *Illinois M J*, 1932, 62 347-349



# THE SURGICAL TREATMENT OF SPASTIC PARALYSIS

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**T**HIS study is based on the results of 280 operations upon 176 patients with cerebral spastic paralysis. All of the operations performed upon the upper extremity were in cases of hemiplegia. Spastic contracture or rigidity at the upper extremity is rarely present in diplegia where the disturbance in function is rather the result of loss of muscle control, athetosis, mass reaction, and inco-ordination.

Only a relatively small number of patients with spastic paralysis are amenable to surgical treatment. While no accurate figures are available, it is estimated that the 176 patients operated upon were selected from approximately 1,500 cases. Treatment in the majority of patients, should consist only of education, muscle training, occupational therapy, prevention of deformity, and correction of mild contractures by muscle stretching and educational methods. However there are frequent instances where correction of contractures or impairment of function can be accomplished only by surgical means.

It should be our aim to consider surgical treatment as only an important and sometimes necessary adjunct to a broad therapeutic regimen. While this is the ideal conception in the treatment of the patient with spastic paralysis it is not always possible. Unfortunately, it is the exception rather than the rule that skilled mental and physical training is available. To be efficient this requires individual instruction over a prolonged period of time on the part of trained personnel. The majority of the patients included in this report have not had available facilities for prolonged pre-operative and postoperative treatment. Hence any improvement resulting after operation must be ascribed to the operation and not to other accessory treatments. An attempt was made to have postoperative training available in all cases of the upper extremity, but in only a few instances was this possible. A reasonable degree of intelligence was considered desirable but not essential before operation was performed upon the lower extremity. On the other hand the use of the upper extremity is intricate and requires at least a fair degree of intelligence to overcome handicaps through postoperative instruction, muscle education, and co-operation on the part of the patient. Fortunately in this

respect contracture at the upper extremity occurs only in cases of hemiplegia which is likely traumatic in origin, and in which low grades of mentality are not common.

In our early experience operation upon the lower extremity was sometimes done before the patient could stand alone, that is, before a definite sense of balance had developed. Occasionally, improvement was rapid and the child was able to walk shortly after operation. Further experience taught us that as a rule it is better to wait until the patient is able to stand alone or walk, or until it is apparent that he could stand or walk provided the contractures were relieved.

In the selection of patients for treatment, training or surgical the question of the patient's mentality commonly arises. For approximately half a century after Little's publications there were practically no attempts made along the line of muscle training. It was supposed that almost all of these patients were feeble minded, and treatment was either not worth while or would be of no avail because of a lack of co-operation. Numerous surgeons observed an apparent improvement in mentality following relief of spasm and contracture, particularly during muscle training. This led many to believe that the mentality in these children is not so low as was formerly assumed and that a good mind may be masked behind the distortions of the facial muscles, the grimaces of athetosis, or the spasms and deformities of the extremities. It is now known that there is frequently a lack of correlation between motor handicaps and the mental condition. Some patients with a marked degree of speech impairment or loss of muscle control reveal a high degree of intelligence while others with practically no motor impairment are idiots. The difficulties involved in the interpretation of mental tests and measurements have been studied by Doll (2) in connection with his research at Vineland. At Spalding School in Chicago one third of a group of 150 children classed as spastics were said to have been mentally normal. Doll (3) said: "It is thus evident that the mental condition of birth injured children must be evaluated with more caution since motor handicap is not to be relied on as an index of the mental condition. Yet to most observers the physical difficulties which these cases present are so

extreme that one is likely to underestimate the child's capacity."

At the close of the first decade of the present century surgical treatment in spastic paralysis had been confined chiefly to stretching of muscles, tenotomies, and tenectomies. Surgeons agreed fairly well upon the usefulness of these methods. There was no agreement, however, on the value of tendon transplantation, and favorable results were attributed to a far greater degree to the removal of the deforming force rather than to the extending action of the flexor muscle. Early work directing the attack upon the central nervous system was in progress. Indeed, we may note the trend of treatment from multiple tenotomies during the first decade to posterior nerve root and motor nerve resection during the second decade, and then through ramisection during the third decade.

Attempts at nerve anastomosis, one peripheral nerve with another, were made by Spiller whose results at first seemed very promising. Steindler showed that while direct neurotization of paralyzed muscle was possible, muscle already supplied by healthy nerve does not take on an additional nerve supply. The clinical application of this is the impossibility of taking some of the nerve supply of the flexors and adding it to that of the extensors.

The suggestion of resection of posterior nerve roots to deal with spasticity and athetosis came from Spiller in 1905, but credit is usually awarded to Foerster who in 1908 and 1909 presented an exhaustive treatise on the theoretical and practical aspects of radicotomy. The Foerster operation was received with great enthusiasm, but has fallen into disfavor chiefly because of the high mortality, the difficult technique, and the inability to localize the effect of root resection to particular groups of muscles.

In 1908, Nutt proposed intraperineural neurotomy with division of the peripheral nerve and immediate suture. Allison and Schwab, impressed with the lack of permanent results following tenotomy, advocated alcohol injection of nerves leading to selected muscle groups. Stoffel proposed selective nerve resection for the purpose of diminishing motor nerve impulses permanently. This method rapidly received recognition and was popularized in this country by Gill.

Sympathetic ramisection, first proposed by Royle and Hunter in 1924 and followed by several subsequent reports, received world wide interest. It is now the opinion of most contributors to the subject that the clinical employment of ramisection in spastic paralysis has

failed to give amelioration of symptoms which the first cases seemed to promise.

This brief review is interesting, for of the various methods of surgical treatment which have stood the test of time there remain only motor nerve resection (Stoffel) and the usual orthopedic principles of tenotomy, tendon transplantation, and arthrodesis. The operations forming the basis of this report are tenotomy or tendon lengthening, motor nerve resection, arthrodesis, tendon transplantation, or a combination of these methods adapted to the individual case. End-results will be classified according to the type of operation and the location.

The interpretation of results of treatment is difficult. While results cannot be obtained comparable with the almost complete restoration of function possible in other deformities, a sufficient degree of improvement can be obtained to encourage continuation of efforts to lessen disability as much as possible. From a previously hopeless situation the parents of these children are appreciative of any gain in function. The relief of an unsightly and disabling contracture and physical and moral encouragement unquestionably stimulate the intelligent patient to a better social adjustment. On the other hand our effort is a failure when the correction of deformity does not result in the improvement in function of the part.

#### MOTOR NERVE RESECTION

*Internal popliteal nerve.* In several cases a previous lengthening of the tendo achillis had resulted in a recurrence of the deformity. Final decision to lengthen the tendo achillis in addition to motor nerve resection was reserved until the patient was completely relaxed under anesthesia. If, during that time, the foot could not be dorsiflexed to a right angle it was assumed that a structural shortening of the muscle existed, and a plastic lengthening of the tendon was done. In all cases a plaster cast was applied immediately after operation, with care to hold the foot corrected only slightly beyond a right angle. This is most important in order to prevent a subsequent calcaneus deformity.

Results of internal popliteal nerve resection in cases of hemiplegia have been excellent in each of the 43 cases. There has been no calcaneus and no recurrence. Some of the patients now have a slight equinus which is not progressing. This is attributed to conservatism of nerve resection, and particularly to conservatism in fixation of the foot in dorsiflexion only slightly beyond a right angle. In none of these cases, however, was this slight equinus objectionable.



The next group of cases consisted of 20 operations upon 10 patients with a bilateral equinus deformity with no particular spasm of the hamstrings or adductor muscles. This group also gave excellent results. There is no calcaneus in any, but in one case there was a recurrence of equinus deformity. In this particular patient lengthening of the tendo achillis was done in addition to the Stoffel technique. I do not believe that the failure was due to the choice of method but rather to error in judgment in not excising enough nerve.

A third group of cases consisted of 44 operations upon 22 paraplegic patients who also had severe contractures of the hip adductors, and in some contracture of the hamstrings as well. The results in this group of cases showed a recurrence of equinus in 2 cases and a calcaneovalgus deformity in 2 cases. While the results were good they were not as uniformly satisfactory as in the less severe types. Even though contractures are relieved it does not follow that a good result will be obtained. Three patients, while relieved of the contractures for which they were operated upon are unable to walk. Mentality is low and there appears to be a complete absence of a sense of balance. Here again, I do not blame the method of the operation itself but attribute failure to poor judgment in the selection of cases for operation.

**Obturator nerve.** Operative treatment directed toward a relief of spastic adduction contracture was not found necessary in any case of hemiplegia. All operations were done in cases of paraplegia. Fifty-four resections of the obturator nerve were done upon 27 patients. Deformity of the feet, which was usually present, was treated by resection of the internal popliteal nerve or by a stabilizing operation. The results of resection of the obturator nerve have been most satisfactory. A sufficient degree of relaxation of the adductor muscles to correct interference at the knees was obtained in all cases. But here again, as in the last group of cases studied, relief from the adductor spasm does not necessarily indicate a good functional result for without a sufficient degree of a sense of balance and co-ordination the patient may still be unable to walk. Three patients were not appreciably improved. Therefore in order to make the operation worth while cases must be selected with care. Resection of the obturator nerve will relieve spastic adduction provided there is not a severe structural shortening of the muscles as determined by marked limitation to abduction while the patient is relaxed under anesthesia. When this is present

adductor tenotomy is also done. There have been no instances of overcorrection of the deformity or a complete paralysis of the adductor group. Immediately after the completion of this operation a double spica cast is applied holding the legs abducted to a moderate degree. The cast is removed at the end of 4 weeks when walking is encouraged.

**Sciatic and external popliteal nerves.** Only 4 operations were done on the sciatic nerve with failure to relieve flexion contracture of the knee in both cases of paraplegia. This operation was therefore discontinued and other methods were used to overcome flexion deformity at the knee. Transplantation of the hamstring tendons and Chandler's transplantation of the patellar tendon downward have given much more satisfactory results, particularly the latter which will be discussed under tendon transplantation.

There were 7 operations performed upon the external popliteal nerve to relieve spasm of the peroneal muscles in conjunction with a triple arthrodesis of the tarsal joints. There was no recurrence of the deformity in either case but in later cases it was thought to be more rational to transplant the peroneal muscles to the inner border of the foot in conjunction with the triple arthrodesis. This not only removes a deforming force but possibly assists actively in maintaining correction.

**Median nerve.** The indications for which the Stoffel operation was proposed on the median nerve are spastic contracture of the fingers and thumb, and a spastic contracture of the forearm in pronation. Accordingly with this object in mind 18 operations were performed upon 18 patients with hemiplegia. The technique as described by Stoffel and Gill was used. In some cases a preliminary splint to hold the forearm in supination and the wrist and fingers in extension was applied. Immediately after the operation a plaster cast was applied with the forearm supinated and the fingers and wrist fully extended. The cast was worn as a rule about 4 weeks. After the removal of the cast exercises and muscle training were applied for a variable period of time depending on the co-operation of the patient and physical facilities. There were no cases in which tenotomy or lengthening of the flexor tendons of the wrist or digits was done in addition to the nerve resection. In 3 cases a tenotomy of the pronator radii teres was done in addition to division of its nerve supply. The indication for tenotomy was inability to supinate the forearm completely while the patient was under anesthesia. In 4 cases the bundle lead ing

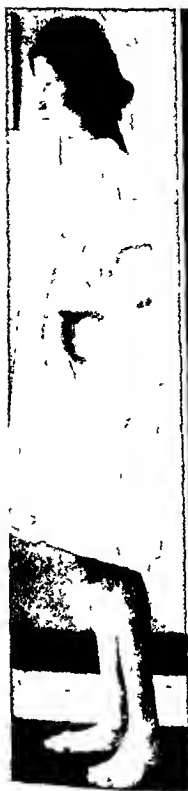


Fig 1



Fig 2

Fig 1 Recurrence of equinus deformity after 2 operations to lengthen the tendo achillis. There has been no recurrence following a third operation when this was combined with resection of the nerve supply to the gastrocnemius.

Fig 2 Illustration shows result following bilateral



Fig 3

nerve resection at the obturators and internal popliteals.

Fig 3 Stofiel's operation of median nerve in spastic hemiplegia. The bundle to the pronator radii teres, flexor carpi radialis, and palmaris longus, was resected together with the bundle to the flexor sublimis digitorum muscle.

to the pronator radii teres, the flexor carpi radialis, and the palmaris longus muscles were resected together with the nerve supply to the flexor sublimis digitorum. This was for relief of pronation contracture of the forearm and flexion contracture of the fingers. In 10 cases the operation was directed toward relief of pronation contracture alone as there was no particular contracture of the fingers present.

The end-results were excellent for the relief of pronation contracture of the forearm. In all cases there has been practically a complete loss of resistance to passive supination, and in most of them there is good active power in supination. I continue to believe, therefore, that this aspect of the Stofiel operation to the median nerve has a distinct value. The results are permanent, and this operation is better than tenotomy alone or

transplantation of the insertion of the pronator radii teres according to the method of Tubby. The results of the latter operation will be discussed later.

The results for improvement in function of the fingers, however, are disappointing. Three of the 8 cases are complete failures, 2 have only a fair result, and 3 have good results. A good result means that the patient has good active power in flexion of the fingers with little difficulty in extending them so as to be able to open the hand sufficiently to grasp. The tight flexor spasm of the fingers was relieved in all cases, but in spite of splinting and exercise 5 patients of the 8 could not extend the fingers at will. In these no particular improvement in function resulted. In 2 patients there remains severe palmar flexion of the thumb which is held curled up in the palm.

Failures are indicated by a marked weakness of the extensors of the fingers or an inability to contract these muscles at will. The fine synergic control of the muscles of the hand cannot be restored simply by weakening the flexor groups. In 4 cases an ulnar deviation of the hand at the wrist occurred resulting likely from the paralysis of the flexor carpi radialis.

The end results, therefore, of the Stoffel operation on the median nerve are as a whole unsatisfactory. Pronation contracture of the forearm can be relieved, but, as a rule, there will be but little improvement in the use of the fingers. One can not ignore, however, the 3 good results. This means that good results may be obtained in properly selected cases, but the difficulty arises in the selection of them. I would limit the Stoffel operation as applied to the fingers to those cases in which a distinct improvement in the use of the hand is made by preliminary splinting of the wrist and fingers in the cock up position. If this improvement fails to be maintained and deformity recurs after the splint has been discontinued, an operation to lessen the pull of the flexors may be of benefit. One must have assurance, in other words, that the patient has at least some voluntary power in extension of the fingers while the wrist is in a position of extension.

One may briefly summarize the results of 187 Stoffel operations on 103 patients by saying that motor nerve resection is of great value in the lower extremity but of limited value in the upper extremity. The operation prevents recurrence of deformity which has been corrected by tenotomy, and in some cases corrects deformity caused by muscle spasm. It is directed toward the relief of spasticity of definite local groups of muscles and is not indicated in any generalized diffuse spasm of an entire extremity.

#### TENDON TRANSPLANTATION AND ARTHRODESIS

*Transplantation of the pronator radii teres (Tubby).* This operation was done upon 4 patients for the relief of pronation contracture of the forearm. The broad insertion of the pronator radii teres was exposed and entirely severed. The tendon was passed between the radius and ulna and secured by means of silk sutures passed through a drill hole well around the posterior lateral aspect of the radius. The results were all failures. There was not only a failure to gain voluntary supination, but there remained the same resistance to passive supination. All these operations were done before the Stoffel operation was tried and the results present a marked contrast to the good results obtained by resection of

the nerve supply to the pronator radii teres muscle as discussed in the first section of this paper.

*Tendon transplantation of the wrist and fingers.* Since results obtained by the Stoffel operation on the median nerve were generally unsatisfactory because of inability to extend the fingers and wrist, an attempt was made to combine the good features of the Stoffel as regards the relief of pronation contracture with tendon transplantation of the wrist flexors into the extensor tendons of the thumb and fingers. Of course the usual Stoffel method, which resects the nerve bundle leading to the flexor carpi radialis as well as to the pronator radii teres had to be modified if we wished to transplant the former. At one operation the median nerve was exposed and with great care the bundle leading only to the pronator radii teres muscle was resected leaving the nerve supply to the flexor carpi radialis intact. This was done with the assistance of direct electrical stimulation to the nerve. A plaster cast was then applied holding the forearm in supination. Later when examination proved that the flexors of the wrist were functioning a second operation was done namely transplantation of the flexor carpi radialis around the radius and attaching it to the extensor tendons of the thumb and index finger, and transplantation of the flexor carpi ulnaris around the ulna and attaching it to the extensor tendons of the middle, ring and little fingers. It was hoped that the pull of these tendons on the extensors of the fingers would enable the patient to hold the wrist in extension as well as to enable him to open the fingers to a degree sufficient to grasp. Of course good voluntary power of flexion of the fingers with no real spastic shortening was considered essential before operation. These operations were done at first, with an enthusiasm which gradually waned as time passed to determine the results. While flexion deformity of the wrist was corrected there followed an ulnar deviation at the wrist which sometimes resulted in a hand which looked worse than before operation. Function of the fingers was also not particularly improved. The proximal phalanges were held extended at the metacarpophalangeal joints but there was no improvement in the flexion deformity of the interphalangeal joints. The function of the fingers was therefore only slightly improved. Upon second thought this is what one would expect. A pull on the extensor tendons does not extend the interphalangeal joints but only the metacarpophalangeal joints. In paralysis of the musculospiral nerve a similar tendon transplantation is satisfactory because the patient has not

lost the ability to extend the distal 2 phalanges

Before realizing this an attempt was made to prevent ulnar deviation at the wrist, caused by the spastic flexor carpi ulnaris passed around the ulna, by performing an arthrodesis of the wrist. It was supposed that a bony ankylosis would prevent ulnar deformity at the wrist. Accordingly arthrodesis of the wrist was done on 10 patients. In 5 of these the arthrodesis was combined with transplantation of the wrist flexors as described above. Again ulnar deviation occurred in some cases in spite of arthrodesis. The deforming force of the flexor carpi ulnaris, which appears to be much stronger than that of the radialis, pulled the wrist ulnarwards in spite of arthrodesis.

Arthrodesis of the wrist either alone or combined with tendon transplantation gave better results than tendon transplantation alone. However, 5 failures to prevent severe adduction deformity out of 11 cases indicated that this method of treatment was not satisfactory in a high percentage of cases.

*Crossed tendon transplantation* Since it was believed that adduction deformity at the wrist was caused by the excessive spastic pull of the flexor carpi ulnaris, a method of transplantation was next devised crossing the tendons of the flexor carpi radialis and ulnaris attaching the ulnaris tendon to the radial side of the hand and the radialis tendon to the ulnar side. Instead of the usual technique of passing these tendons around the lateral aspects of the ulna and radius, they were passed between these bones just above the wrist. This technique was followed in 16 cases. In 4 of these the flexor carpi ulnaris was sutured to the extensor tendons of the thumb and index finger, and the flexor carpi radialis to the extensor tendons of the middle, ring, and little fingers. In 4 cases the same method of tendon transplantation was done combined with arthrodesis of the wrist. In still another group of 8 cases arthrodesis of the wrist was done combined with crossed tendon transplantation to the bones on the dorsal aspect of the wrist, the flexor carpi ulnaris to the radial border and the flexor carpi radialis to the ulnar border. In none of these 16 cases did adduction deformity at the wrist occur. Therefore, the object of this method of crossed tendon transplantation was realized. Inability to extend the fingers accounts for failure to improve the function of the hand in 4 cases. Crossed tendon transplantation then, is regarded as important in preventing adduction deformity at the wrist in spastic paralysis, for in my experience the usual tendon transplantation of the flexor carpi radialis to the extensor tendons on the

radial side of the hand and of the flexor carpi ulnaris to the extensor tendons on the ulnar side of the hand is followed in many cases by a more or less severe adduction deformity. It is not expected that tendon transplantation of a spastic muscle will activate antagonistic action. It is helpful chiefly in removing a deforming force and acting as a passive support.

#### SUMMARY OF RESULTS OF TENDON TRANSPLANTATION AND ARTHRODESIS OF WRIST, SEPARATELY OR COMBINED

Conclusions as to the value of tendon transplantation and arthrodesis, separately or combined, are based on the results of 34 operations. Seven were cases of uncrossed tendon transplantation of the wrist flexors to the finger extensors, 6 were cases of arthrodesis of the wrist alone, and in another 5 arthrodesis was combined with uncrossed tendon transplantation to the bones of the wrist, 4 were cases of crossed tendon transplantation to the extensors of the fingers, 4 were cases of crossed tendon transplantation to the extensors of the fingers together with arthrodesis of the wrist, and finally 8 were cases of crossed tendon transplantation to the bones of the wrist combined with arthrodesis. It is evident from these confusing figures that attempts at several combinations of tendon transplantation and arthrodesis of the wrist have not resulted in a single satisfactory method of improving the function of the spastic hand. The most satisfactory results, however, have followed arthrodesis of the wrist combined with crossed tendon transplantation to the wrist or extensor tendons of the fingers. A decision is not easily arrived at as to whether one should transplant the wrist flexors to the bones of the wrist or to the extensors of the fingers.

Objection may be raised as to the efficacy of transplantation of a spastic muscle, particularly to a contrary position. In practice these objections are partially confirmed. However, in a goodly proportion of cases improvement in power of extension of the fingers can be obtained by this means not possible by any other method.

Selection of cases for operation is not easy. If, when the flexed wrist is held passively in extension and the patient is still able to open the fingers sufficiently to grasp, assuming, of course, that there is good voluntary flexion of the fingers, crossed tendon transplantation will likely hold the wrist in extension without adduction deformity. If there is difficulty in extension of the fingers while the wrist is held passively extended, tendons are transplanted to the extensors of the thumb

Failures are indicated by a marked weakness of the extensors of the fingers or an inability to contract these muscles at will. The fine synergic control of the muscles of the hand cannot be restored simply by weakening the flexor groups. In 4 cases an ulnar deviation of the hand at the wrist occurred resulting likely from the paralysis of the flexor carpi radialis.

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*Tendon transplantation at the wrist and fingers* Since results obtained by the Stöffel operation on the median nerve were generally unsatisfactory because of inability to extend the fingers and wrist, an attempt was made to combine the good features of the Stöffel as regards the relief of pronation contracture with tendon transplantation of the wrist flexors into the extensor tendons of the thumb and fingers. Of course the usual Stöffel method which resects the nerve bundle leading to the flexor carpi radialis as well as to the pronator radii teres had to be modified if we wished to transplant the former. At one operation the median nerve was exposed and with great care the bundle leading only to the pronator radii teres muscle was resected leaving the nerve supply to the flexor carpi radialis intact. This was done with the assistance of direct electrical stimulation to the nerve. A plaster cast was then applied holding the forearm in supination. Later when examination proved that the flexors of the wrist were functioning, a second operation was done, namely, transplantation of the flexor carpi radialis around the radius and attaching it to the extensor tendons of the thumb and index finger, and transplantation of the flexor carpi ulnaris around the ulna and attaching it to the extensor tendons of the middle ring and little fingers. It was hoped that the pull of these tendons on the extensors of the fingers would enable the patient to hold the wrist in extension as well as to enable him to open the fingers to a degree sufficient to grasp. Of course, good voluntary power of flexion of the fingers with no real spastic shortening was considered essential before operation. These operations were done at first with an enthusiasm which gradually waned as time passed to determine the results. While flexion deformity of the wrist was corrected there followed an ulnar deviation at the wrist which sometimes resulted in a hand which looked worse than before operation. Function of the fingers was also not particularly improved. The proximal phalanges were held extended at the metacarpophalangeal joints but there was no improvement in the flexion deformity of the interphalangeal joints. The function of the fingers was therefore only slightly improved. Upon second thought this is what one would expect. A pull on the extensor tendons does not extend the interphalangeal joints but only the metacarpophalangeal joints. In paralysis of the musculospiral nerve a similar tendon transplantation is satisfactory because the patient has not



Fig 6

Fig 6 Crossed tendon transplantation to the wrist together with arthrodesis. There is no adduction deformity. The tendon of the flexor carpi ulnaris was passed between the radius and ulna and attached to the radial border of the wrist. There has been a moderate improvement in the function of the hand.

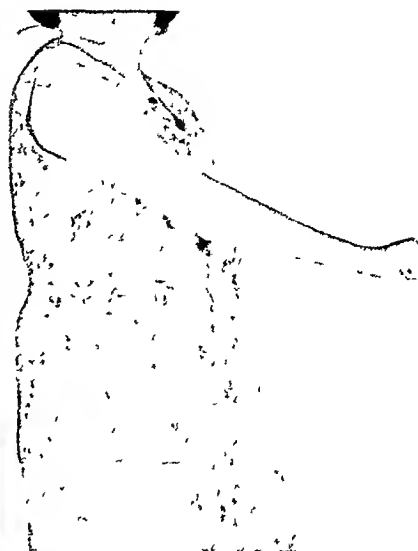


Fig 7

Fig 7 Arthrodesis of the wrist has resulted in inability to extend the fingers. The patient was formerly able to extend the fingers by flexing the wrist. One must be cautious when advising arthrodesis of the wrist without tendon transplantation to the extensor tendons of the thumb and fingers.

transferring the action toward the extension of the knee.

*Transplantation of the patellar tendon (Chandler's operation)* In 1933 Chandler, at a meeting of the Clinical Orthopedic Society in Chicago, demonstrated patients upon whom he had transplanted the patellar tendon downward at the knee (2). Since that time the writer has done 10 of these operations on 6 patients, all with spastic paraplegia. Results have been very satisfactory, and each patient now has active power in completely extending the knees when sitting and walking. This operation was proven to be so satisfactory that, in my hands, it has completely displaced transplantation of the hamstrings. Of course, as in transplantation of tendons elsewhere, complete passive extension of the knee must be possible beforehand, obtained either by stretching, tenotomies, or capsuloplasty, for tendon transplantation alone will not overcome contracture.

*Arthrodesis and tendon transplantation at the foot* Deformity of the foot other than a pure equinus has been observed with relative infrequency. This accounts for the few operations to correct a lateral deformity of the foot in spastic paralysis. Twenty operations were done on 12 patients for varus or valgus deformity. Subastragalar arthrodesis together with transplanta-

tion of the peroneus longus or tibialis anticus was done upon 14 patients, and in one case arthrodesis alone was done. Tendon transplantation in conjunction with arthrodesis removes the constant deforming force of a spastic muscle and lessens the likelihood of recurrence of deformity. The results of all these operations were satisfactory. It is believed necessary to dress these feet in a little more overcorrection than is done following arthrodesis of the foot to correct a paralytic deformity, as there seems to be a greater tendency toward recurrence. Subastragalar arthrodesis together with tendon transplantation solves the problem to correct valgus or varus deformity of the foot in spastic paralysis. Arthrodesis alone is apt to result in a recurrence of the deformity.

*Posterior nerve root resection (Foerster) and sympathetic ramisection* While it is not intended in this report to discuss the merits of nerve root resection and sympathectomy, brief comments will be made to record unfavorable impressions following my observation of patients operated upon by others. Two patients were under observation several years after posterior nerve root resection. Both had large trophic ulcers and a flaccid paralysis of the lower extremities with calcaneovalgus deformity and flexion contractures at the knees. One patient was incontinent and



Fig 4

Fig 4 Arthrodesis of the wrist together with uncrossed tendon transplantation. Note the severe adduction deformity. The tendons of the flexor carpi radialis and the flexor carpi ulnaris were passed around the radius and ulna respectively and attached to the carpus. This



Fig 5

deformity is common with this method of transplantation.

Fig 5 Nerve resection to the pronator teres muscle only. At a second operation the flexor carpi radialis and flexor carpi ulnaris were transplanted to the distal end of the wrist according to the crossed technique.



and fingers otherwise the patient would be unable to open the fingers sufficiently to grasp. With arthrodesis of the wrist it is advisable to transplant the wrist flexors. These muscles would have no function anyway after arthrodesis and when transplanted according to the crossed technique they will prevent adduction deformity. A large number of patients, however, have fair function in spite of a flexed position of the wrist for by flexing the wrist they are able to extend the fingers. It is best not to interfere with this type of hand. Possibly transference of the origin of the extensors further upward on the humerus would improve the ability to hold the wrist and fingers extended.

On the whole the results of tendon transplantation and arthrodesis in the upper extremity are encouraging. In a selected group of cases, however, a great improvement in function of the hand can be obtained by these measures. Spastic flexion of the thumb across the palm seriously interferes with the ability to grasp. Arthrodesis of the carpometacarpal joint together with tenodesis of the abductor pollicis longus to the lower end of the radius has been partially successful in holding the thumb out of the palm.

*Transplantation of the biceps femoris.* This operation was done to prevent sagging of the

knees in flexion. This was always bilateral and has not been observed in any case of hemiplegia. Fifteen operations were done on 9 patients.

The usual technique was employed, namely, a small piece of the bony attachment at the head of the fibula was removed together with the biceps tendon and this was secured into a groove in the patella. Complete passive extension of the knee was a prerequisite before operation. One can not expect a transplanted tendon to overcome contracture. In 2 cases flexion contracture was severe, and required posterior capsuloplasty according to the method of Philip Wilson in order to obtain complete passive extension before tendon transplantation. In 5 cases the result was satisfactory. These patients are able to walk with the knees almost completely extended. In 2 the result was considered only as fair in the remaining 2 cases no benefit whatever was derived. Possibly a higher percentage of good results may have been obtained by transplanting both the external and internal hamstrings. The same objections hold true here as with transplantation of spastic muscle at the wrist. Possibly the same percentage of good results could have been obtained by tenotomy or tenectomy of the hamstrings. Tendon transplantation was done in order to utilize this force if possible by

# A TECHNIQUE OF THYROIDECTOMY PERMITTING THE USE OF SILK

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**T**HE general principles of thyroidectomy have become standardized but important variations and refinements of technique have been described in recent years which have improved results and decreased operative complications. The technique developed in this clinic has increased rapidity of recovery, decreased hospital morbidity, eliminated drainage, decreased incidence of infected wounds, and diminished incidence of postoperative complications.

In 1920, Pemberton suggested the primary superior polar attack for substernal thyroids and from the principles outlined our present method has been evolved. This method of attack is now applied to all types of goiters with equal effectiveness. Guthrie (1936) stated that the advantages of the method are obvious when the primary superior polar method used in substernal goiter is compared with the technique of rapid elevation, which is attended so often by an increase in respiratory difficulties instead of in their improve-

ment, which may necessitate the rapid and vain search for a hidden and deformed trachea in a neck already filled with thyroid before elevation of more thyroid, which carries with it the danger of further stretching an already overstretched recurrent laryngeal nerve, and which may be associated with deep alarming hemorrhage due to the pulling off of the inferior thyroid artery and vein, or both, and thus cause injury to the recurrent laryngeal nerve, the internal jugular vein, or the parathyroids, as a result of hectic efforts to control the severe and alarming hemorrhage.

Since the employment of this operative method, there has been a marked reduction in the post-operative respiratory and voice complications and there has been no need for tracheotomy for the relief of such complications. Lahey has recently advised that the recurrent laryngeal nerve be visualized and dissected out in order to prevent its injury and subsequent voice changes. Guthrie, however, believes that severing the inferior

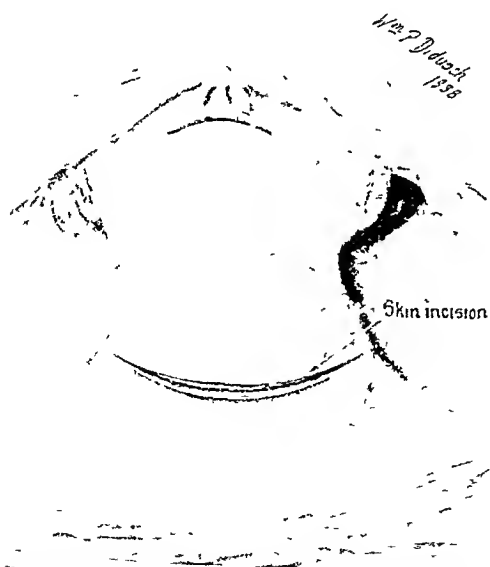


Fig 1 In those patients with large thyroids the incision is placed high to prevent its prolapse upon the chest wall

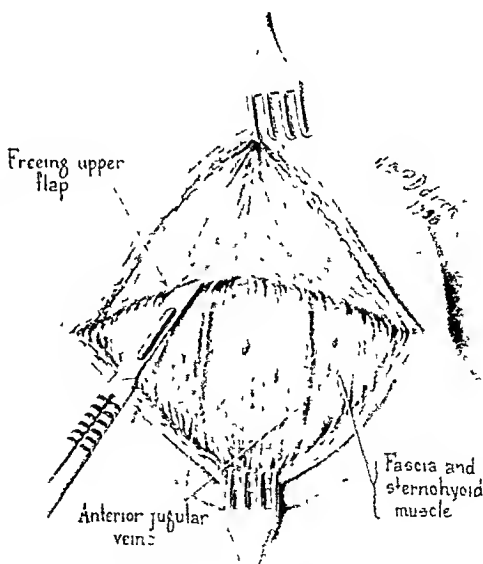


Fig 2 Sharp dissection of the upper flap of the incision is carried out



died 10 years after operation because of sepsis. Ten patients were studied following sympathetic ramisection, and I have not been impressed with any improvement over their previous condition. In 2 cases of paraplegia where the operation was done on only one side there was no appreciable difference between the operated and the unoperated sides. These observations in general agree with other reports. One can not ignore however the careful studies of Steele Stewart who has had great experience with sympathectomy.

#### CONCLUSIONS

In this study of end results of the surgical treatment of spastic paralysis the striking contrast of poor results attending operation at the upper extremity as compared to good results at the lower extremity is apparent. Motor nerve resection combined with tenotomy when necessary has proved to be satisfactory in correcting equinus deformity and adduction contracture at the hips which are the deformities most commonly encountered. The likelihood of overcorrection of the deformity is more theoretical than real, for with care in judgment in the execution of nerve resection this should not occur. Valgus or varus instability or deformity at the foot may be corrected by subastragalar arthrodesis combined with tendon transplantation. Motor nerve resection of the sciatic nerve to control flexion deformity at the knee has been discarded as being of little value, and transplantation of the biceps femoris has been attendant with only indifferent success. Transplantation of the patellar tendon downward—advancement of its insertion—has shown such superiority over other methods to correct flexion deformity at the knee as to displace them entirely. I have had no experience with Durham's procedure of dividing the insertion of the internal rotator muscles at the hips to correct internal rotation contractures. His results are convincing and his method will be used when the opportunity arises.

To improve the function of the upper extremity is a much more difficult problem and is still not possible in many cases. It is best not to interfere with many of these for an injudicious operation

may result in an impairment of what little function exists. Motor nerve resection at the upper extremity has a narrow field of adaptability except for relieving pronation contracture of the forearm. Arthrodesis and crossed tendon transplantation offer better chances of success in carefully selected cases resulting occasionally in striking improvement. However, even with various combinations and methods the results of tendon transplantation and arthrodesis have been as a whole disappointing. While the nature of the lesion precludes curative treatment the application of surgical methods unsatisfactory as they are, is often an indispensable and in further educational treatment.

#### REFERENCES

1. ALLISON A. and NEWMAN S. I. Muscle group I slitting and nerve anastomosis in the treatment of the paralysis of the extremities. *Am J Orthop Surg* 1919 9 95.
2. CHANDLER I. A. Reestablishment of normal range of the patella in knee flexion deformity in spastic paralysis. *Surg Gynec & Obst* 1913 5 53.
3. DOLL F. A. Crippled Child 1913 10 121.
4. DOLL F. A., JENNINGS W. M. and MILLER R. T. Neonatal Deformity Due to Birth Injuries. New York Macmillan Co 1932.
5. DEARIE H. A. A procedure for the correction of internal rotation of the thigh in spastic paralysis of knee & joint Surg 1914 20 310.
6. FOERSTER O. Ueber eine neue operative Methode der Behandlung postischer Lähmungen mittels Kettentheilung hinterer Rückenmarksnerven. *Zschr f orthop Chir* 1908 22 203.
7. GILL A. B. Steifel's operation for postic paralysis with report of twenty four cases. *J Orth p Surg* 1921 3 57.
8. GERT J. J. Intra peroneal neurectomy in spastic paralysis. *J Bone & Joint Surg* 1911 4 453.
9. PAVLE V. D. New operative procedure in the treatment of postic paralysis. *Med J Australia* 1914 1 77.
10. SPILLER W. C. and FARRER C. H. The treatment of cerebral palsies and athetosis by nerve anastomosis and transplantation. *J Nerv & Ment Dis* 1905 32 310.
11. SPINDELE A. Textbook of Operative Orthopedics. New York D Appleton & Co 1925.
12. STEWART S. E. End results of ramisection in spastic paralysis. *J Bone & Joint Surg* 1927 9 724.
13. STROBEL A. Eine neue Operation zur Beseitigung der spastischen Lähmungen. *München med Wochenschr* 1911 58 2471.

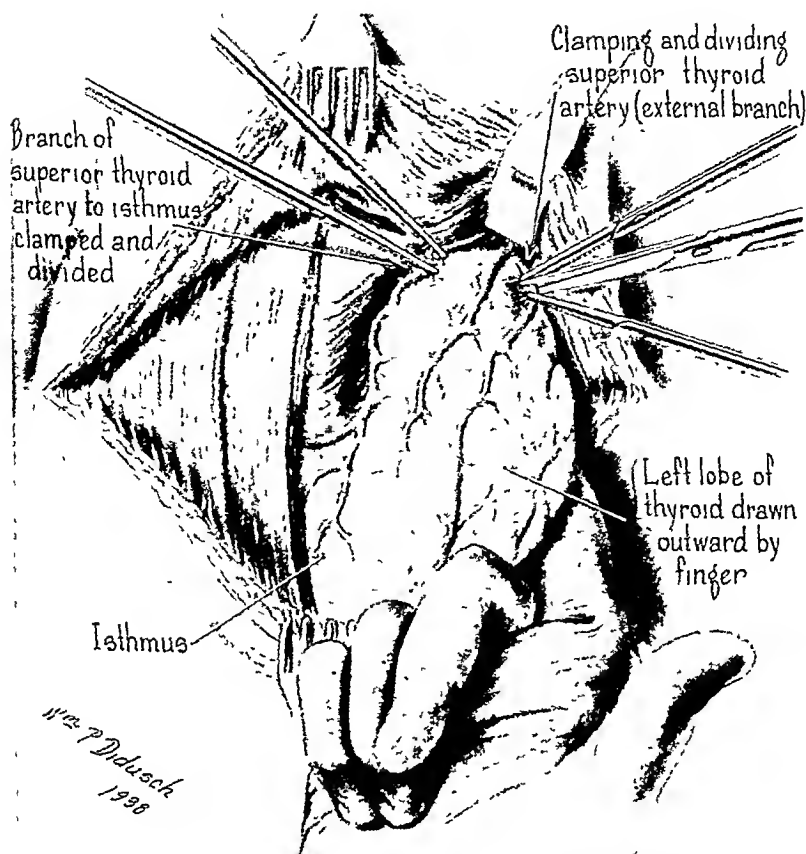


Fig 7 Method of clamping and dividing the superior thyroid artery with gentle elevation of the gland

silk in tissue than to catgut. They showed that silk knots and sutures become encapsulated early by a fibroblastic capsule. We have had a chance to verify this fact in secondary lobectomies which are performed 7 to 10 days after the primary operation. We have been amazed to find in this short period of time all silk ligatures encapsulated. Whipple, in 1933, emphasized the principles laid down by Halsted, and the spreading popularity of silk is largely due to his efforts. He emphasized the necessity of sharp dissection, complete hemostasis with fine pointed forceps, avoidance of mass ligatures and undue tension, interrupted sutures, avoiding the combination of silk and catgut in wounds, and the use of only the finest grades of silk in clean wounds. These principles are rigidly observed in our thyroidectomy technique. Guthrie and Sharer (1936) stated that in thyroid surgery the desire to close the wound if possible without drainage necessitated the use of

large amounts of catgut for complete hemostasis. The exudative response to this material caused serum collections which often required drainage and thereby invited infections. The swelling and softening of catgut about larger vessels may result in hemorrhage which may be concealed. Silk has been advocated for the solution of these difficulties. Guthrie and Sharer, in 1935, reported its use in ligation of all vessels while the hemostasis of the thyroid remnant was secured by a running lock suture of No. 0 iodized catgut. Before this change of technique, drainage was employed routinely. This method permitted 60 per cent of the wounds to be closed without drainage. The wounds drained were particularly those with large unobliterated cavities. By this method there was a definite reduction in the incidence of wound infections and serum collections. Goiter patients in this clinic have been routinely tested for sensitivity to silk and it has been found that,

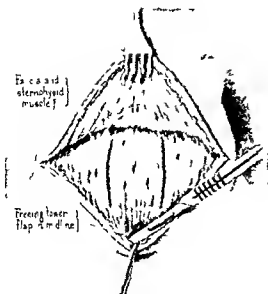


Fig. 3. Freeing the lower flap in the midline only over the suprasternal notch.

thyroid vessels high up on the gland and then ligating the vessels in the long axis of the neck safeguards the recurrent laryngeal nerve against injury at this point.

The technique which we now employ permits the safe use of silk. Halsted was the first surgeon

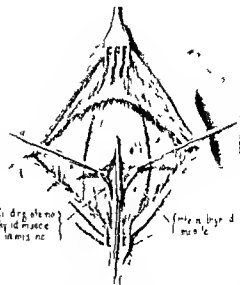


Fig. 4. Division of the fascia and the muscles in the midline.

in this country to use silk in wound repair and the principles he proposed have not been improved upon. He believed that even in the presence of slight infections, fine silk sutures would not be extruded. Howes and Harvey have shown that there is much less exudate and cellular response to

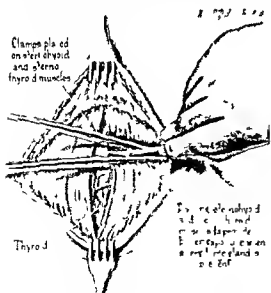


Fig. 5. Dividing the sternohyoid muscle to provide an adequate exposure.



Fig. 6. Freeing the thyrohyoid muscle completely from its attachment to the lobe of the thyroid.

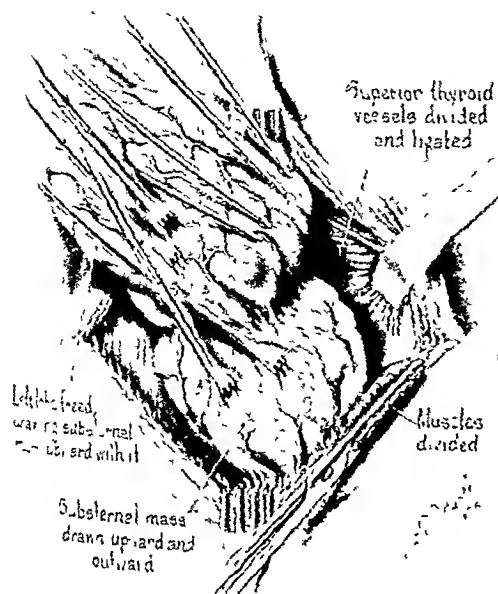


Fig 9 Illustrating the method of elevating a substernal mass by gentle traction after primary mobilization of the superior pole and severing the lateral veins

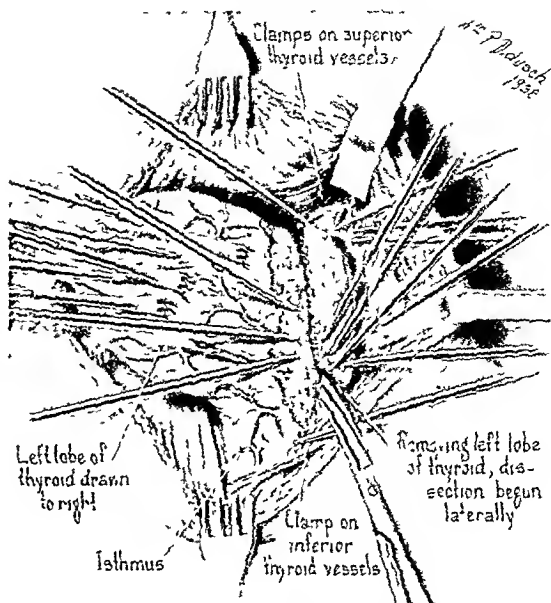


Fig 10 Dissection of the lobe continued to show what should be the size of the thyroid remnant that is to be left *in situ*

drawing after 2 weeks. By improving the technique of regional anesthesia in 1935 drainage was reduced to 52 per cent. Collier reported, in 1937, that he uses drainage routinely in his cases.

#### TECHNIQUE OF SUBTOTAL THYROIDECTOMY

It is most important to obtain the best exposure of the thyroid bed at the beginning of the operation. The low collar incision (Fig 1) extends from the external jugular vein of one side to its fellow of the opposite side, and the skin and platysma of the upper flap are reflected upward to the level of the thyroid cartilage notch (Fig 2). It has been found best not to dissect the lower skin flap except slightly at the suprasternal notch (Fig 3), because separation of this flap is not necessary for exposure and its dissection encourages the formation of serum pockets. All vessels are caught by fine pointed Kelly hemostats and ligation is performed with fine silk. In dissecting the flap, care is taken to avoid cutting the anterior jugular veins. If these veins are injured the heart side of this vein is immediately clamped to prevent air embolism, as previously described by the senior author. At the point of injury the vein is completely severed before ligation because it is believed that there is less likelihood of the sutures slipping off as the operation proceeds and retraction is used. At this point all

forceps which have been used to secure vessels on the flaps and muscles are removed after ligation of the vessels. The fascia and muscles are

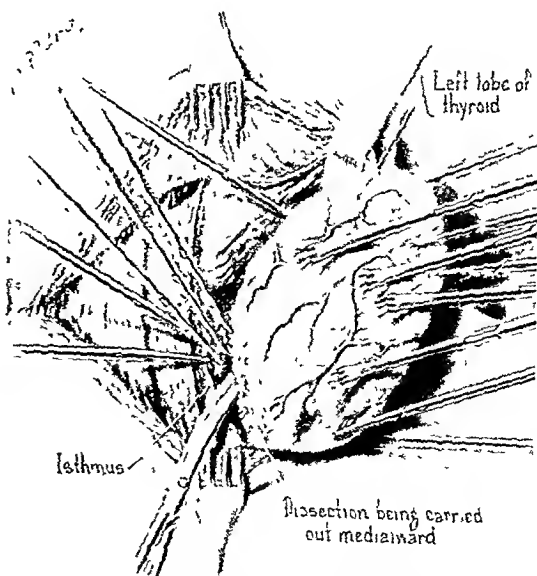


Fig 11 Dissection of the lobe from the trachea showing remnant of the gland left along the trachea



Fig. 4. Upper pole is mobilized by gentle downward traction.

even in those who react strongly positive the tendency to serum collection is definitely less than for catgut. The silk used in all cases has been fine Dicksel or a fine German made white silk.

In 1935 when silk was used for ligatures and remnants were sutured by a lock stitch of iodized No. 0 catgut 63 per cent of the wounds were healed at the time of discharge. A summary of the cases up to June 22, 1937 showed that 6 per cent were closed without drainage and 61 per cent of these healed without serum collections while 3 per cent of the drained cases healed primarily. A total of 82 per cent of these patients were healed at time of discharge. Before the rubber sponge pressure dressing was routinely used in silk and catgut cases 40 per cent of the wounds were draining after 13 days but since the adoption of this dressing for all garter cases only 1 per cent were draining after 13 days. Further in cases in which silk and catgut were both used serum collections were noted in 32 per cent.

In a review of the last 150 cases which have been completely done with silk there has been only one case requiring drainage. The drains were removed in 24 hours and primary healing resulted. There have been only 5 cases which developed serum collections and the 6 became dry after a single drainage of the serum. Of the 150 cases there has been only one infected wound which was slight and subsequently healed with out extrusion of sutures.

When these figures are compared to reviews of case for previous years there has been a remarkable improvement since the present technique has been used. Another very important point is that subternal goiters which were previously drained now rely are now closed without drainage and without fear of mediastinitis. It was our custom formerly to drain these pockets freely at least 3 or 4 days. At the Mayo Clinic Zellhoefer in 1913 found that when local anesthesia was used in 80 per cent of the cases the wounds were

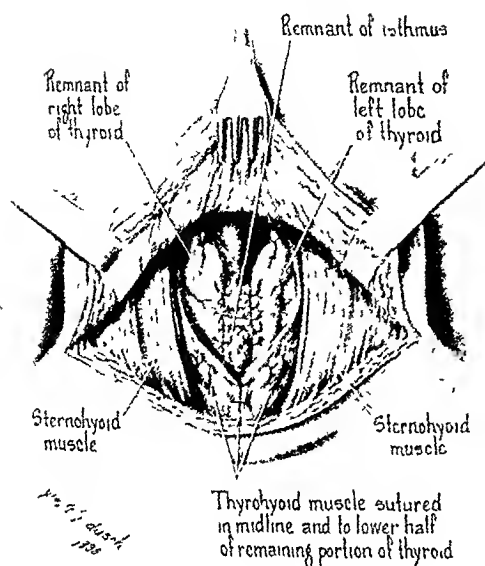


Fig 13 Thyrohyoid muscles are sutured at the midline and to the lower portion of the remnant

interarytenoid muscles. The dissection then extends to the lateral thyroid veins, which are clamped and ligated. With this amount of mobilization the upper pole is elevated and drawn gently downward from without inward or in a reverse manner, the manipulations of the surgeon being guided by the respiration of the patient and the helpful co-operation of an experienced anesthetist.

In the dissection at this stage it is best to leave small amounts of thyroid tissue on the trachea and at the side for protection of the trachea itself and for anchoring the remnant. It was formerly thought that the lower pole was most frequently the site of nerve injury, but it is now well known that injuries take place most frequently in the groove between the esophagus and the trachea or near the upper pole. Lahey believes that many of these nerve injuries come from attempts to control troublesome hemorrhage from a branch of the inferior thyroid artery supplying the remnant left along the side of the trachea, and he advises that the inferior thyroid artery be ligated to control such hemorrhage.

The ascending branches of the inferior thyroid artery are next encountered and after these are severed a wide degree of mobility of the gland is found possible. In fact, very often a large substernal mass may be elevated into the wound by the most gentle traction without inserting the finger into the mediastinum (Fig 9). This is

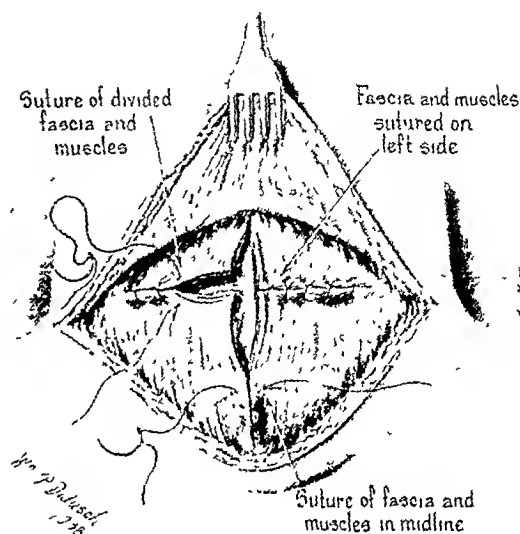


Fig 14 Method used in the closing of the divided sternohyoid muscles

necessary for ligation of the lower pole and removal of the gland.

The remnant of the lobe is outlined by Kelly hemostats placed along the periphery of the lobe (Fig 10), as the lobe is divided the blood vessels in the thyroid substance are clamped

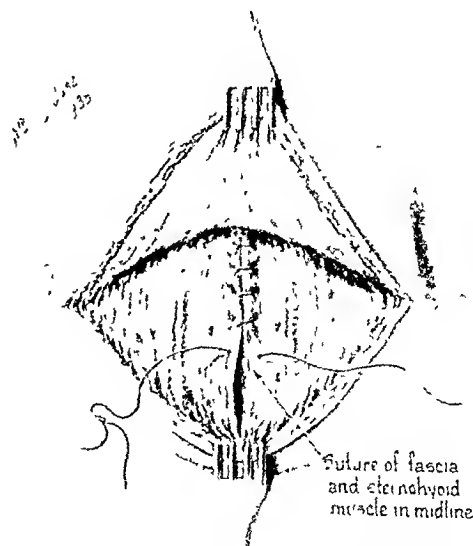


Fig 15 Closure of muscles and fascia in the midline when the sternohyoid muscles are not divided

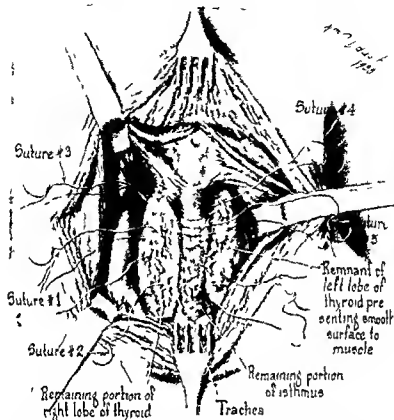


Fig. 12 Method of controlling hemorrhage from the remnant by two rows of interrupted fine silk sutures placed at different levels in the long axis of the neck. In interrupted sutures are placed through the edges of the remnant and the fascia and thyroid tissue of the trachea investing the outer surface of the remnant to conceal its incised surface.

separated in the midline (Fig. 4) and at the supra sternal notch care is taken to avoid injury to the venous jugular arch. The sternohyoid muscles may be clamped and divided on one or both sides and the sternomastoid may be separated from the sternohyoid muscle and retracted laterally if exposure is inadequate (Fig. 5). Free separation of the thyrohyoid muscle from the gland is important (Fig. 6).

The larger thyroid lobe is attacked first. The lobe is elevated by gutter tenacula and the suspensory fascia severed. As the upper pole is elevated the branches of the superior thyroid artery are clamped by Kelly hemostats and divided (Fig. 7). There are usually three or five terminal branches. After severing the arterial branches the superior pole which tends to be flattened and wedge-shaped rolls outward from

its bed with perfect ease (Fig. 8). After the pole is mobilized a small strip of thyroid is left to form the upper part of the remnant in order to protect the recurrent laryngeal nerves which are the most vulnerable in this area of the thyroid field. It is believed that dividing the branches of the superior thyroid artery rather than the main artery or mass ligation of the superior pole has many safeguards. It avoids a mass ligature which often must be placed with poor exposure and under tension thus lessening the chance of immediate or post-operative hemorrhage from the superior thyroid vessels. We believe this prevents injury to the blood supply of the parathyroid because of the absence of permanent tetany in more than 4,000 of our operative cases. It also safeguards the internal branch of the superior laryngeal nerve which is now known to contain motor fibers to the

the wound This dressing is covered by two pieces of sterile cotton and the entire dressing is bound snugly to the neck by means of a gauze bandage

On the day following operation the dressing is removed and every other skin clip is removed. The pressure dressing is replaced by a flat gauze dressing After 48 hours the remaining skin clips are removed while after the fourth or fifth post-operative day the dressing may be disposed of entirely

The patients are discharged in from 8 to 10 days after operation, this period of time being necessary for the symptoms of hyperthyroidism to quiet down Hospital morbidity is thus from 3 to 7 days less than for previous methods.

#### SUMMARY

The technique of subtotal thyroidectomy as performed in this clinic, and as shown by the illustrations and the description has proved satisfactory.

The use of silk in thyroid surgery is entirely justified by the results that have been obtained in wound healing

#### REFERENCES

1. COLLEP, F A, and BOYDEN A M The development of the technique of thyroidectomy Surg, Gynec & Obst. 1937 65 495
2. GUTHRIE, DONALD Thyroidectomy technique The postoperative care of the toxic goiter patient Am J Surg 1929, 6 631
3. Idem Die Geisshren der Lutembolie mit besonderer Beruecksichtigung der Thyroidektomie Wien klin Wchnschr, 1937, 50 1667
4. Idem The advantages of the primary superior polar attack in the removal of substernal thyroids Ann Surg, 1936, 84 251
5. GUTHRIE, D and EVANS, R L The dangers of air embolism in thyroidectomy West J Surg 1933, 41 497
6. GUTHRIE DONALD, and SHARER, ROBERT Use of avertin and silk in thyroidectomy Guthrie Clin Bull, 1935, 5 5
7. HALSTED, W S Ligature and suture material (employment of silk) J Am M Ass, 1913, 40 1119
8. HOWES, E L, and HARVEY, S C Tissue response to catgut absorption and silk, and wound healing Internat. J Med & Surg, 1930, 43 225
9. LAHEY, F H Routine dissection and demonstration of recurrent laryngeal nerve in subtotal thyroidectomy Surg, Gynec & Obst, 1938, 66 775
10. ZELLHOEFER, H W K Healing of thyroidectomy wounds after regional anesthesia Proc Staff Meet, Mayo Clin, 1935, 10 773



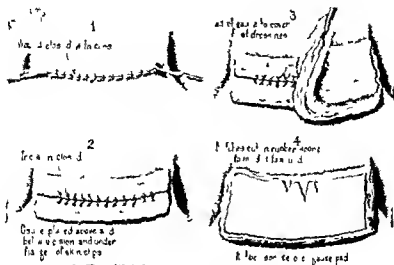


Fig. 16. Illustrating the method of dressing the wound

(Fig. 11) All vessels are ligated with fine Dek-natel or a German made white silk. The remnant is fairly dry and is dropped into the thyroid bed while the remaining lobe is removed in a similar way. Two rows of interrupted fine silk sutures are placed in the cut surface of the remnant in the long axis of the neck for hemostasis and not too deeply placed to protect the nerves and parathyroids (Fig. 12). The remnants are then drawn to the midline and sutured by fine silk to the fascia of the trachea and the thyroid tissue is left along the trachea. The thyrohyoid muscles are then brought back to their original location and sutured together and to the lower portion of the remnant. This is an additional aid to complete hemostasis (Fig. 13). Closure is accomplished by

using interrupted fine silk sutures (Fig. 15). When the sternohyoid muscles have been divided the severed ends of the anterior jugular veins are ligated separately by transfixion sutures and then the edges of the muscles are sutured together by interrupted sutures (Fig. 14). The skin edges are brought into exact approximation and Van Wachenfeldt clips are applied (Fig. 16, 1). Beneath the flanges of the clips on either side a saline soaked gauze is then placed over the closed wound as shown in Figure 16, 2, and the entire wound is covered by a flat dry gauze dressing (Fig. 16, 3). In ordinary flat rubber sponge with notches cut in the upper ridge to permit molding to the neck is placed as in Figure 16, 4, for distribution of pressure over the entire area of



Fig. 17. Illustration of the condition of the wounds on the fourth postoperative day



Fig. 18. Shows the condition of the wound on the seventh postoperative day

infection does not go by way of the blood stream or lymphatics but travels along the cavity of the uterus to the tubes

As a result of this study, 5 conclusions were reached (1) When a patient had a complete occlusion at the uterine end of the tube, tubal infection did not recur and pus tubes did not develop, (2) that the uterus was the necessary avenue through which the infection reached the tubes from the cervix and the external genitalia, (3) that even in the presence of the uterus, a total absence of infection from the internal os downward prevented re-infection, (4) the cured infected tube did not spontaneously re-infect itself, (5) salpingitis did not develop in those patients in whom the connection between the uterine cavity and the tubes had been broken in spite of a gonorrheal infection of the lower genital tract

It was then argued that if these conclusions were correct, 1 of 4 procedures could be followed in order to prevent re-infection of the tubes. (1) Clear up all foci of infection and not allow sex trauma, (2) do a hysterectomy, (3) remove the infected tubes with or without fundectomy, or (4) resect the tubes at the cornu of the uterus

Which procedure should be followed? Procedure 1 could be followed if the patients would co-operate, but it is usually impossible to prevent sex trauma. Infections have occurred in some cases following sex trauma where one could absolutely exclude re-infection from the consort. As a result of the impossibility of control the first procedure, although it can be carried out, is usually doomed to failure

Procedure 2, or hysterectomy, is rather radical surgery for infected tubes, patients will not submit to it, the mortality and morbidity is too high, and it breaks every principle of preserving as much of the pelvic organs as possible

Procedure 3, or the removal of the tube with or without resection of the fundus, is an excellent procedure but still somewhat radical. In removing the tubes with or without a piece of the fundus, the blood supply to the ovaries may be interfered with, and those patients on follow-up frequently present ovarian cysts with associated symptoms

Procedure 4, or the resection of the tubes, carries with it a minimum of surgery, and if it will clear up the condition and prevent re-infection, it should be the method of choice

Tubal resection is indicated in those patients who have had repeated attacks of salpingitis covering a period of one year with a relative disability or incapacity for work during this time. They should give a history of sterility during this

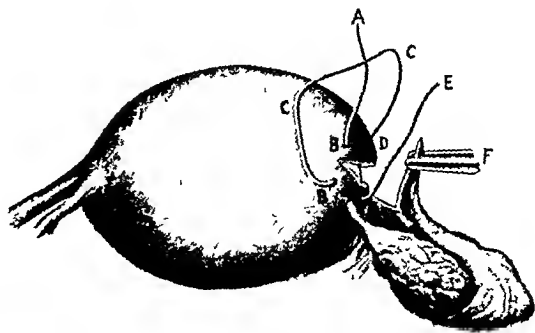


Fig 1 Figure-of-8 suture A, B, C, D, E, inserted through the cornu of the uterus, clamp F applied to uterine end of tube. V shaped excision of the uterine end of tube. The mesosalpinx is cut close to the tube so as to free slightly the uterine end of the tube

period and on vaginal examination should show persistent palpable masses

Surgically the requirements are that the patient be a good surgical risk as far as her other vital organs are concerned. She must have had a normal temperature for at least 14 days with a leucocyte count of less than 10,000 and a sedimentation time longer than 30 minutes for 18 millimeters in the Linzenmeyer tube

#### TECHNIQUE OF THE OPERATION

The abdomen is opened by a left paramedian incision from the symphysis to the umbilicus. After insertion of the self-retaining retractor, 3 laparotomy pads are placed so as to pack away the omentum and intestines. The adhesions of the omentum and small intestines to the pelvic organs are severed by blunt or sharp dissection. The fundus of the uterus is identified and the adnexa are inspected. *The condition of the ovaries is the deciding factor for the type of operation to be performed.* If ovarian pathology such as abscess or cyst is found, a salpingo-oophorectomy is performed. If no ovarian pathology is found, a resection of the tube can be carried out

A figure-of-8 stitch (Fig 1, A-B-C-D-E) is inserted in the uterine horn, proximal to an artery clamp (Fig 1, F) placed on the uterine end of the tube. A V shaped excision of the uterine end of the tube is carefully made so as not to injure the underlying ovarian branch of the uterine artery. The proximal end of the tube is then freed from its mesosalpinx by cutting the mesosalpinx close to the tube for a distance of about 1 centimeter. The figure-of-8 suture, A to E, in the uterus is tied, left long, and a clamp is applied

# TUBAL RESECTION AS A TREATMENT FOR RECURRENT GONORRHEAL SALPINGITIS

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**S**ALPINGITIS is a well defined clinical entity and constitutes one of the most important chapters in gynecology. The salpingitides are divided on an etiological basis into 3 groups: gonorrheal salpingitis, septic salpingitis, and tuberculous salpingitis. In this discussion the term recurrent salpingitis will be used as a synonym for recurrent gonorrheal salpingitis.

Practically every case of primary gonorrheal infection of the tube can be cured if reinfection can be prevented. A woman who is financially able to take care of herself and who is willing to follow instructions carefully can be promised an almost complete recovery under proper medical treatment. The difficulty in any large city lies in the following facts: first, the patients not understanding the seriousness of their condition will not follow the instructions given them; second, if they understand the seriousness of the condition and desire to follow the instructions, they cannot because of their financial condition which requires them to return to work too soon; and lastly, most of these patients have to support themselves, therefore they cannot interrupt their periods of occupation too frequently or they lose their positions. As a result of these factors a great many patients in our city institutions must be operated upon not because of the pathology present but to prevent frequent attacks of incapacitating symptomatic salpingitis.

What operative procedure shall be the one of choice in these cases? Salpingectomy is a relatively safe and useful operation if practiced in accordance with the principles laid down by Simpson and Curti. Yet it has several disadvantages: (1) It has a primary mortality of 1 per cent and a fairly high percentage of postoperative morbidity. (2) The technical difficulties encountered during the operation frequently leads to radical surgery of the ovaries and uterus, producing a surgical menopause which is contrary to all principles of conservative gynecology. (3) Postoperative exudates or indurations may require prolonged treatment or even a secondary

operation (Morriss 58 per cent). Postoperative cyst formation in the ovaries due to impaired circulation and postoperative adhesions producing symptoms do occur. (4) The loss of the fallopian tubes occasionally has a bad psychological effect on some patients.

The operation to be described is presented as a conservative procedure to prevent the above described sequelae. It retains the tubes and prevents their reinfection. The observations (2) which furthered the belief that this procedure would and could prevent reinfection of chronically infected tubes were that:

1. In spite of the known fact that a gonorrheal infection of the tubes is always bilateral, patients were seen frequently who had a pus tube on one side and a fairly normal tube on the other. As a result of this observation several of these apparently normal tubes were removed and examined. It was found that the apparently normal tube there always had obstruction at the uterine cornu, whereas the tube on the other side, the connection with the uterine cavity seemed to be maintained.

2. When a hysterectomy was performed on a patient with chronic bilateral tubal infection, the inflammation disappeared and reinfections did not occur. In looking over the literature, hysterectomy is found to be described as a treatment for pus tubes (4).

3. When a patient with quiescent pus tubes was adequately treated so as to remove all gonorrheal infection from the lower genitalia (cervix, urethra, etc.) and she was separated from her contact to prevent reinfection, the tubal infection as a rule cleared up and did not recur.

4. Simpson and Curti have shown that gonorrheal salpingitis is a self-limited disease and the organisms die in the tube 2 weeks after the temperature is normal. As a result the tube cannot re-infect itself; the infection must come from without the tube.

5. Those patients whose tubes had been resected close to the uterus for sterilization purposes never developed salpingitis in spite of a gonorrheal infection of the lower genital tract (cervix, urethra, etc.) thus showing that gonorrheal

Read before the Section of Obstetrics and Gynecology of the 46. Army of Medicine, New York City, Dec. 20, 1937.

5 patients had small masses, 6 patients had larger masses

*Clinical* 76 patients reported themselves clinically cured or asymptomatic; 13 patients had slight symptoms, 6 patients had definite symptoms

*Economic* 83 patients were able to perform their usual work, 12 patients had sufficient symptoms to interfere with work

No patients have had to be re-admitted for severity of the symptoms or for a recurrence of a salpingitis. There have been no re-operations on account of pelvic disease. One patient who had a bilateral resection was re-operated upon 14 months later for intestinal obstruction. The obstruction was due to upper abdominal pathological conditions. A negative pelvis was found

#### CONCLUSIONS

Cornual resection of the tubes is offered as a surgical procedure for the cure of recurrent gonorrheal salpingitis. It involves a minimum of surgical trauma and in 112 cases gave the follow-

ing results: (1) no primary mortality, (2) no primary pelvic morbidity, (3) 70 per cent perfect, 14 per cent good, and 7 per cent fair anatomical results; (4) 79 per cent symptom free patients, 21 per cent with slight symptoms; (5) 87 per cent fit for manual labor, 13 per cent with only partial incapacity, (6) no re-operations for pelvic disease, and (7) no re-admissions for recurrent salpingitis

#### REFERENCES

- 1 CURTIS, A. H. Bacteriology and pathology of fallopian tubes removed at operation. *Surg, Gynec & Obst*, 1921, 33, 621
- 2 FALK, H. C. Tubal resection as treatment for recurrent salpingitis. *Am J Surg*, 1936, 33, 509
- 3 NORRIS. Gonorrhea in Women, p. 44. Philadelphia: W. B. Saunders Co., 1913
- 4 ROBINSON, BYRON. The Utero-Ovarian Artery. Chicago: E. H. Colegrove, 1903
- 5 SHUPROV, F. F. Choice of time for operation for pelvic inflammation of tubal origin. *Tr Am Gynec Soc.*, 1909, 34, 161
- 6 Idem. A precise method of choosing a safe time for operation in pelvic inflammation of tubal origin. *Tr Am Gynec Soc.*, 1915, 40, 166

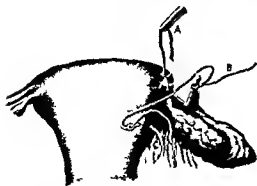


Fig. 2 A Cornual figure-8 suture tied. Ligature placed around uterine end of tube B and tied. Long end of suture threaded on a needle and passed through posterior wall of the uterus C, from medial to lateral under the round ligament of ovary.

A ligature is then applied to the cut end of the tube (Fig. 2, B) and the clamp is removed. The long end of this suture is threaded on a needle which is passed through the posterior wall of the uterus below the round ligament of the ovary (Fig. 2 C) and tied. This automatically causes the cut end of the tube to be inverted under the tube itself (Fig. 3, B). The same procedure under the same conditions is carried out on the other side.

### RESULTS

In this series 112 patients have been operated upon. The first operation was performed May 17, 1934, the last included in this series was done on November 28, 1936.

*Pre-operative data.* The youngest patient was 20 years old, the oldest was 42. 87 patients were in the 20 to 29 year group, 23 in the 30 to 39 year group, and only 2 were 40 years or over. The shortest pre-operative stay in the hospital was 2 days, the longest period 60 days, and the average was 17.3 days. All patients complied with the routine conditions and indications for the operation.

The operations performed were as follows: bilateral resection in 5, patients, left salpingo-oophorectomy, right tubal resection in 37, right salpingo-oophorectomy, left tubal resection in 28, ovarian suspension in 18, uterine suspension in 92, and appendectomy in 70.

The following pathological lesions were seen at operation and allowed to remain in the pelvis: A small mass, the tube measuring up to 2 centimeters was found 51 times; a medium sized mass pyosalpinx, the tube measuring 3 to 4 centi-

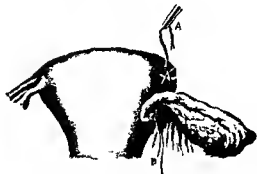


Fig. 3 All sutures tied. Uterine end of tube inverted covering all raw areas.

meters was seen 35 times, a large mass, the tube measuring more than 4 centimeters in diameter, occurred 26 times.

In 106 patients the operations were performed as the operation of choice, on 6 occasions they were performed as operations of necessity. In these latter cases the surgeon's intention was to do some other type of procedure but the difficulties encountered made it advisable to shorten the operation. As a result a cornual resection was resorted to instead of the usual salpingectomy or salpingo-oophorectomy. The 106 operations of choice were performed without operative complications and without drainage. The 6 operations of necessity were all drained: 4 abdominally and 2 vaginally.

### POSTOPERATIVE COURSE

In the group of the 106 cases one patient had a pulmonary complication which delayed the patient's discharge until the twentieth postoperative day. All other patients were discharged on the twelfth to the fourteenth day. There were no wound infections. In the 6 patients in whom the operation was one of necessity, all were discharged from the thirteenth to the twenty-ninth day.

*Follow-up.* Ninety-five patients or 85 per cent of those operated upon have been seen in the follow-up clinic one or more times. The duration of observation ranged from 2 to 30 months. All patients are usually seen 6 weeks after the operation and thereafter at bi-monthly intervals. Some patients have been seen only once, most of them on several occasions.

The results have been tabulated on an anatomical, clinical and economic basis.

*Anatomical.* 67 patients had an absolutely negative pelvis; 17 patients had induration only.

5 patients had small masses, 6 patients had larger masses

*Clinical* 76 patients reported themselves clinically cured or asymptomatic, 13 patients had slight symptoms, 6 patients had definite symptoms

*Economic* 83 patients were able to perform their usual work, 12 patients had sufficient symptoms to interfere with work

No patients have had to be re-admitted for severity of the symptoms or for a recurrence of a salpingitis. There have been no re-operations on account of pelvic disease. One patient who had a bilateral resection was re-operated upon 14 months later for intestinal obstruction. The obstruction was due to upper abdominal pathological conditions. A negative pelvis was found

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# ENCAPSULATED INTRAMEDULLARY TUMOR INVOLVING THE WHOLE SPINAL CORD FROM MEDULLA TO CONUS COMPLETE ENUCLEATION WITH RECOVERY

GILBERT HORRAN, M.D. F.A.C.S. and DONALD G. HENDERSON, M.D. Boston, Massachusetts

**A**LTHOUGH individual case reports are seldom of sufficient interest to warrant special and detailed tabulation, it so happens that occasionally a patient comes under observation with a condition so unique that one is urged from this standpoint alone to make a note of it if for no other purpose than to put it on record in medical literature. Besides this, in the present instance we feel that there are at least 2 additional points to which attention should be drawn, namely, the possibility of doing an almost complete laminectomy and, secondly, the surprising extent of recovery of function following what amounted to a practically complete anteroposterior transection of the spinal cord throughout its entire length.

## CASE HISTORY

A young woman 29 years of age was referred to The Lahey Clinic and the New England Deaconess Hospital on December 6, 1936 complaining of paralysis of the legs and difficulty with her bowels and bladder. The salient features of her past history were these. She had been admitted to a hospital in another city on September 18, 1930 at which time she had been having high dull backache and for one year was unable to use her legs. Because of her spinal symptoms lipiodol was injected and this was said to have shown a block in the upper dorsal region. Laminectomy was performed on September 29, 1930 at which time the cord was exposed from the level of the seventh cervical to the fourth dorsal vertebra. No pulsation was seen. The dura was opened and the cord appeared edematous. Nothing further was done; the dura and muscles were closed and the condition was thought to be a myelitis. A cyst bladder developed for which a suprapubic cystostomy was instituted.

The patient showed practically no change for about 1 year and then began to have some warning of micturition and a little motion in her legs developed. In January 1932 the cystostomy tube was removed and she was able to void voluntarily. Gradually during the next 2 years the strength of her legs returned and in the spring of 1934 she resumed her former position as cashier in a theater. She was able to walk to and from her work, went to dances and seemed perfectly well for about 1 year. During 1935 she again began having difficulty in walking and this increased to such a degree that by April 1936 she was once more confined to a chair. On November 3, 1936 she was readmitted to the same hospital where she had been before and was transferred from there to Boston. The results of

her blood and spinal fluid Wassermann tests had been negative repeatedly.

When admitted to the New England Deaconess Hospital on December 6, 1936 she presented the following clinical picture. She was a well nourished young woman lying in bed without any great degree of discomfort. Cerebration was normal and her cranial nerves were normal throughout.

**Motor system.** Both legs were almost completely paralyzed although a very slight amount of extension at the knees was possible if the legs were held flexed by the examiner. Both arms and both hands retained fairly good strength, the left being slightly weaker than the right. There was some involuntary flexion of the thighs upon stimulation with a pin point over various areas of the legs and the dorsum of either foot.

**Sensation.** The patient showed a sensory level at the third rib anteriorly and the third dorsal spine posteriorly below which pain and temperature sensations were almost wholly lost, the loss of pain being the more complete of the two. There was marked hypoaesthesia to pain and temperature on the medial aspects of both arms and both hands. Light touch was fairly well preserved over the area just described, there being more diminution of this type of sensation over the lower extremities than the upper. Deep pressure pain was lost in the legs but was present in the arms. Vibratory sensation was lost below the hips, diminished in the left arm and present in the right arm (Fig. 2).

**Reflexes.** All deep reflexes were bilaterally overactive except the Achilles jerks which were absent. There was at times a positive Babinski on the left but no sustained ankle clonus.

**Sphincters.** She had been having difficulty with voluntary control of both bowels and bladder but this loss of function was not complete.

**Lumbar puncture** was carried out on December 9, 1936. The spinal dynamics showed a complete block. The lipiodol which had been injected previously could not be made to pass upward beyond the body of the eleventh dorsal vertebra.

**Spinal fluid examination** showed deeply xanthochromic fluid with a total protein of 1200 milligrams.

**First stage operation.** December 10, 1936. A cervicodorsal laminectomy was carried out and the spines and laminae from the axis to the seventh dorsal vertebra below it (the first to third dorsal had been removed at her operation elsewhere) were removed. Upon incision of the dura over this area the whole length of exposed cord appeared greatly widened and thinned out, the pect being that of a huge cystic cord. The blood vessels on the surface were spread apart and the cord had a grayish color. On the assumption that the condition was syringomyelia a fine needle attached to a syringe was inserted into the widest part of the cervical region but when suction was made no fluid was obtained.

The dorsal a pect of the cord was therefore incised in the midcervical region and at a depth of 2 to 3 millimeters

From the Department of Neurosurgery, The Lahey Clinic and the Pathological Department of the New England Deaconess Hospital.

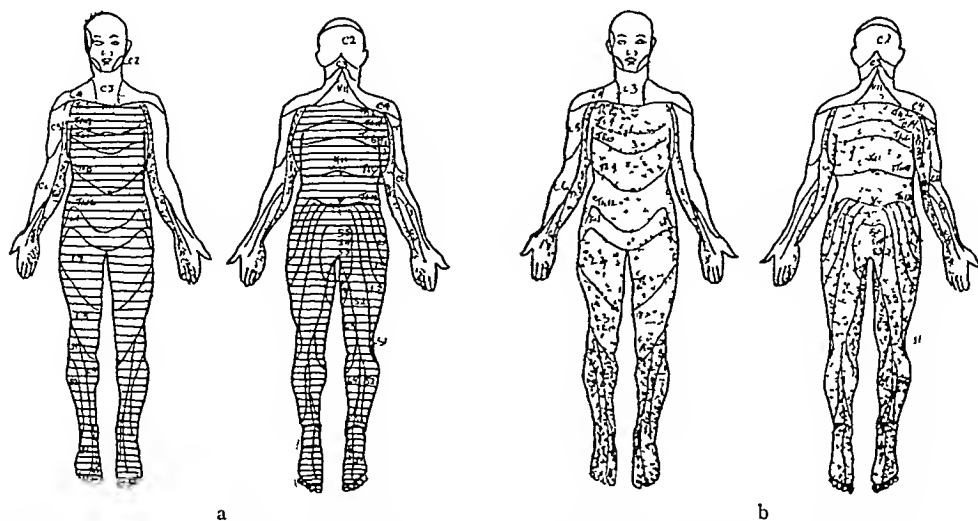


Fig 1 Chart showing the loss of various forms of sensation which the patient showed before operation a, Pain

and temperature, b, light touch Horizontal lined areas analgesia, dotted areas, hypesthesia

the surface of an apparently encapsulated intramedullary tumor was encountered. The growth was quite firm and of a brownish-gray color. The incision in the cord was now carried upward to the lower end of the medulla and downward to the inferior end of the dural opening. There was a tendency for the tumor to bulge through this incision. Growth could be separated from the attenuated cord on either side by gentle retraction and dissection with small moist cotton pledgets, and in this way it was followed upward to its superior pole at the lower limits of the medulla. When this upper pole was freed it could be grasped with a forceps and lifted outward, thus making it possible to peel the tumor out of its bed by gently brushing away the slightly adherent cord tissue below it. In this way it was enucleated down to the lower end of the cord incision at about the level of the fifth dorsal vertebra (Fig 2). Here a silk ligature was tied around the growth and it was divided just above the ligature, the remaining tumor below this (of unknown extent at this time) being left to be taken out at a second stage operation, since the present procedure had lasted some 5 hours or longer. The patient on the whole was in very good condition although toward the latter part of the operation her blood pressure had dropped to about 80 millimeters systolic and 55 millimeters diastolic. She was given a transfusion of 250 cubic centimeters of blood.

The tumor was cylindrical and a little over 2 centimeters in diameter (Fig 3). It almost bisected the cord anteroposteriorly so that along the anterior aspect of its bed there could be seen only 1 to 2 millimeters of cord substance and at some points only the pia and arachnoid had been left.

*Second stage operation, December 16, 1936* At this session the spines and laminae of the remaining dorsal vertebrae as well as the first and second lumbar were removed. After the dura was opened over this area the dorsal aspect of the cord was incised from the lower end of the previous operation down to the end of the conus, thus exposing the remaining portion of tumor which extended the entire length of the cord. This lower end of growth was peeled out in the same manner as at the primary operation. A portion of this lower end of tumor proved to be cystic but with a

definite capsule and not merely a syringomyelic cavity (Fig 4). The cystic contents were first removed so as to gain room and make less damage to the cord, then the capsule of the cystic portion was grasped, lifted outward, and gently dissected free from its bed (Fig 5). The dura and muscles were then closed in the usual careful layers.

*Pathological report* The specimen consisted of 2 parts, roughly cylindrical, and its total length was 38.5 centimeters (Fig 6). The upper piece had a diameter of 2.2 centimeters for a distance of 5 centimeters then gradually narrowed to 1.5 centimeters for the middle 19.5 centimeters. The lower portion of 14 centimeters was a thin walled, tube-like structure 0.5 centimeter in diameter.

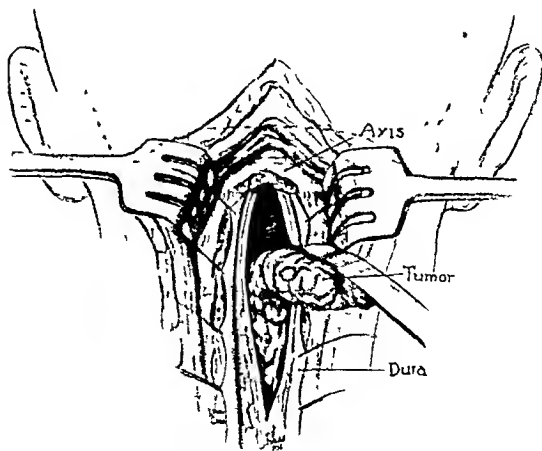


Fig 2 Operative sketch of the first stage enucleation of the upper and larger portion of tumor



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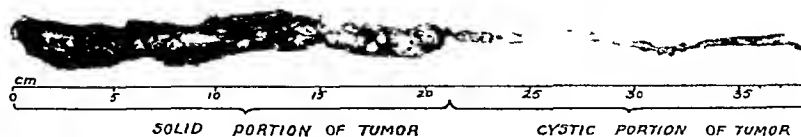


Fig 6 Photograph of the entire tumor, pieced together

charge she had begun to move the toes of both feet and the ankle on the right side, and slight flexion was possible at the right knee. She had regained the function of bowels and bladder which had been lost completely after operation, and was up in a chair several days before leaving. On January 30, 1937 she was discharged to her home, 6½ weeks after her second operation (Fig 9).

**Follow-up notes.** The patient has reported from time to time by letter indicating her progress. She has slowly regained almost full use of her right hand and both arms but the left hand is still somewhat weak. Both legs regained strength slowly, and on June 2, 1937, 6 months after operation, she was able to stand with support. Her back has never given her any trouble from weakness. By July 13, 1937, she was able to take a few steps with support and her letter of October 4, 1937, stated that she was standing and taking steps with support every day, the right leg being much better than the left. Her last letter, February 2, 1938, 14 months after operation, was most encouraging. To quote: "I walk every day with help on each side of me. The right leg is wonderful. I think it is almost back to normal (Fig 10). The left leg has to be pushed along but sensation seems to be better all through the left side."

#### DISCUSSION

A fairly complete review of the literature has revealed only 2 instances of intramedullary tumors, which were encountered at operation and removed, at all comparable in size and length to that of our patient. The first of these was reported by Cushing in 1927.

This tumor was an ependymoma in a girl 8 years of age, and it extended from the medulla to the second thoracic level. The dorsal aspect of the cord was incised as in our case and the growth, which was soft, removed by suction. At this first operation a laminectomy from the atlas to the second thoracic vertebra inclusive was performed. Thinking that the tumor extended below this lower level, a second stage operation was carried out removing the remaining thoracic and the first 2 lumbar laminae. Only a hydromyelic cavity, however, was found throughout this lower end of the cord. The child made an excellent recovery, and was practically normal for 5 years.

The other instance in which a long intramedullary growth was operated upon was Case 3 reported by Foerster and Bailey in 1936. The tumor extended from the first cervical to the ninth thoracic level. It was removed piece-meal at operation, but unfortunately the patient died the following day. The tumor was an astrocytoma.

Several instances of long, intramedullary growths, which were discovered at necropsy, are quoted by Foerster and Bailey in the important article in which they report their own experiences. These are the cases of Hatschek, a myxoglioma of the entire cord, of Miura, a glioma extending from the midcervical to the lower lumbar region, of Nonne, a sarcoma involving the first cervical to the tenth dorsal segments, of Schueppel, a gliomyxoma extending from pons to conus, of Schultze, a gliosarcoma from bulb to conus, of Taterka, a fascicular glioma from bulb to the twelfth thoracic



Fig 7 Photomicrograph of characteristic area of tumor. Note the uniform type of cell with rosette-like formations around the blood vessels.  $\times 100$

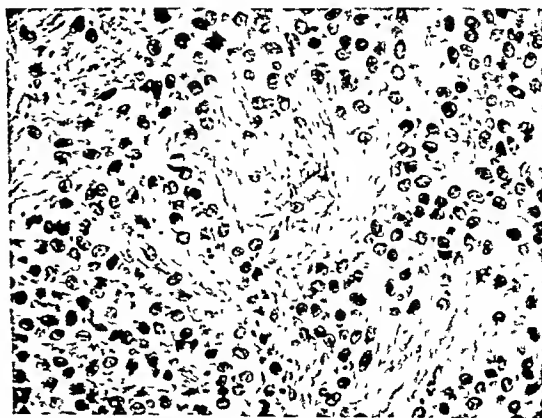


Fig 8 Photomicrograph of a section of the tumor which again shows the rosette-like formation and absence of mitoses.  $\times 150$



Fig. 3

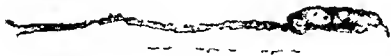


Fig. 4

Fig. 3. Photograph (about two-third natural size) of the upper portion of tumor removed at the first stage.

Fig. 4. Photograph (about 1/2 natural size) of the lower portion of tumor removed at second stage. The narrow part is the cystic area from which the fluid had been evacuated.

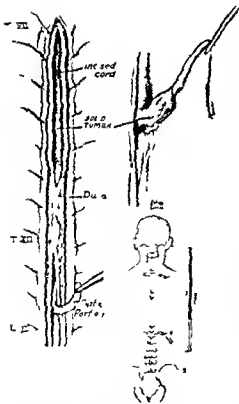


Fig. 5. Operative sketch second stage. It shows the method of enucleation of the tumor. Insert shows the extent of growth.

after removal. It was from this portion that the cystic fluid had been evacuated at operation and when distended its diameter was fully equal to the upper end of the growth.

The tumor grossly had a delicate capsule intact except for small foci of traumatic disruption. A surface network of hyperemic fine blood vessels was apparent throughout and an occasional superficial minute hemorrhage was noted. The upper 2.5 centimeters was soft gray and the cut surface showed the center softer and more hemorrhagic than the periphery. Delicate longitudinal striations were faintly visible in the deeper portions. The tube-like structure was collapsed; it had a smooth white lining, a homogenous elastic wall and a finely shaggy surface.

Microscopically, with hematoxylin-eosin and phosphotungstic acid-hematoxylin, the sections showed no definite capsule but surface layers that were interlacing and gave the appearance of being compressed. The bulk of the tumor was well vascularized. Large cells having scanty cytoplasm and oval nuclei with heavy chromatin network tended to arrange themselves about blood vessels; they were mostly unipolar with the processes extending toward the perivascular spaces (Fig. 2). Between these rosette-like arrangements, smaller cells were growing widely and an occasional large cell could be determined. The stroma was scanty and pleomorphic; it was definite but minimal. Mitotic activity was absent (Fig. 8). An occasional small empty canal lined by open lymphatic cells was present but that was a minor feature. Necrosis was absent. The layers were like perlethine, both inner and outer lining surfaces to be composed of compressed small cells having longitudinally interlacing processes, scanty cytoplasm and oval deeply stained nuclei. The wall was homogeneous and consisted of similar thin larger cells. Microscopically the tumor corresponded to Kernhan's cellular type of ependymoma.

**Postoperative course.** The patient recovered promptly from each of her long laminectomies. Her arms and hands were at first not as strong as they had been before operative interventions but they began to show improvement before she left the hospital. Likewise by the time of her dis-

It might be asked whether merely splitting the whole length of the cord posteriorly and leaving the dura open might not have given her more prompt and complete recovery than she has shown up to the present time. This is a possibility, but in that case she would still retain her tumor and at some future time would have to undergo the same extensive operative procedures with perhaps even greater technical difficulties than at the original session. It does not, therefore, seem to us that such a course would have been advisable.

Another subject which should be mentioned is the ability to recover from a complete antero-posterior transection of the spinal cord. In our own patient this transection was complete in certain places in the cervical region where only the pia arachnoid was visible anteriorly, and throughout the entire cord there were probably only 1 to 3 millimeters of cord substance remaining anterior to the tumor. As told in the patient's follow-up reports, she has recovered the motor function of her right leg almost completely, but sensation is poor in this leg, whereas with the left leg the reverse is true. In Foerster and Bailey's Case 3 a similar complete transection was made, but the ability to recover could not be followed up owing to the death of the patient within 24 hours. No mention was made as to the completeness of the spinal cord transection in the other cases which have been reviewed.

From the pathological standpoint the incidence of primary ependymomas to other intramedullary spinal cord tumors has not been accurately deter-

mined, but in a series of 51 cases Kernohan, Woltman and Adson found that they represented 42 per cent. Of the gliomas in the region of the cauda equina the incidence rises to 68 per cent (8). This type of tumor is relatively slow growing and has not been observed extending outside nervous tissue. The sections of the specimen reported here show no definite capsule, but the compressed surface layers, lack of mitotic activity, and presence of well differentiated cells, all indicate low invasive tendencies.

#### BIBLIOGRAPHY

1. ADELSTEFN, L. J., and PATTERSON, G. H. Surgical treatment of ependymal glioma of the spinal cord. *Arch Surg*, 1935, 30: 997.
2. CAIRNS, H. W., and RIDDICH, G. Observations on the treatment of ependymal gliomas of the spinal cord. *Brain*, 1931, 54: 117.
3. CUSHING, H. The intracranial tumors of pæadolescence. *Am J Dis Child*, 1927, 33: 551.
4. ELSBERG, C. A. Tumors of the Spinal Cord. New York: Paul B. Hoeber, Inc., 1925.
5. FOERSTER, O., and BAILEY, P. A contribution to the study of gliomas of the spinal cord with special reference to their operability. Jubilee Volume for Dawidenkov Leningrad State institute for publication of biological and medical literature, 1936, pp. 9-67.
6. KERNOHAN, J. W., WOLTMAN, H. W., and ADSON, A. W. Intramedullary tumors of the spinal cord. *Arch Neurol & Psychiat*, 1931, 25: 679.
7. KERNOHAN, J. W., and FLETCHER-KERNOHAN, E. M. Ependymomas. A study of 109 cases. *Proc Ass Res Nerv & Ment Dis*, 1935, 16: 182.
8. WOLTMAN, H. W., KERNOHAN, J. W., and ADSON, A. W. Gliomas in the region of the cauda equina. *Proc Staff Meet Mayo Clin*, 1932, 7: no. 27.

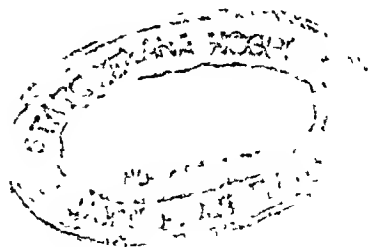




Fig. 9 Photograph of operative team at the time of the patient's discharge

vertebra of Thielen, a neuro-epithelioma gliomatousum from the upper cervical region to the conus and of Zinn another neuro-epithelioma gliomatousum from the first cervical to the conus.

The second question which would seem appropriate to discuss in connection with the case reported here has to do with the actual operation performed. The propriety of removing intramedullary tumors completely has been questioned, since at times more damage may be done to the cord by radical removal than would have been the case had the dorsal columns merely been incised the tumor allowed to extrude partially and then more or less completely removed at a secondary operation. This method was advocated by Elsberg in 1925 and doubtless has its advantages in soft infiltrating tumors. Furthermore, it has been held as almost axiomatic that an attempt to extirpate intramedullary growths involving the fourth cervical segment should not be made because of the grave danger of respiratory cessation.

So far as both these questions are concerned there is now considerable evidence in the literature, including our own case to make us believe that in the encapsulated tumors such as the ependymoma here reported a careful complete extirpation no matter what the level is the procedure of choice. This attitude is taken by



Fig. 10 Snapshots of the patient at her home March 16 1935

Kernohan, Woltman and Adson (6) and re-emphasized by Adson (1935) in his discussion of the important paper by Kernohan and Fletcher Kernohan (7). Mention has been made already of the patient operated upon by Cushing in 1927 in which no untoward feature occurred during the removal of the cervical portion of an extensive ependymoma. Other cervical intramedullary growths which have been extirpated radically without serious respiratory upset were reported by Cairns and Kiddoch (1931) by Adelstein and Patterson (1934) and by Foerster and Bailey (Case 7) 1936. On the other hand in Case 4 of Foerster and Bailey death was caused by respiratory paralysis.

An interesting point in reviewing our own case comes out in the extraordinary relief of symptoms which the patient obtained after her original small exploratory laminectomy in 1930. It will be remembered that at this time the dura under the upper 3 thoracic vertebrae was opened the cord inspected and the dura again closed. She remained paraplegic for approximately a year then gradually improved for 2 years and during the year 1934 she resumed her usual work walking about going to dances and so forth. It is difficult to explain this improvement on the basis of the operation but it may be that during the ensuing year there was sufficient atrophy of the vertebrae by pressure from the tumor to give a spontaneous decompression to the cord.

At the time of our operation patient was paraplegic with beginning sphincter incontinence



Fig 1 a, left, Fresh fracture, immobilization in non-padded plaster for 6 weeks, time off from work 8 weeks b, Appearance after 6 weeks

first hour after injury. Early recognition and treatment thus being made possible, open reduction of any fractured bone was the exception, because of the ease of closed reduction in an early case. We maintain that the practice of waiting overnight or days later to accomplish a reduction is a serious mistake and conducive to unfavorable results. The newer school advocates open operation with bone graft inlay for these fractures and reports good results in all cases. About one third of this series of scaphoid fractures were simply immobilized upon cock-up splints in a position of moderate dorsiflexion and slight radial flexion. In the latter two thirds we applied unpadded plaster casts with the wrist in the same position, and with the thumb fully abducted and incorporated in the cast. The plaster extended only to the distal palmar crease, thus allowing full movement of the fingers. The fact that end-results in all cases were the same argues for the belief that early treatment is the keynote, not the method nor the fixation in any exaggerated position. There can be no question concerning the efficiency of unpadded plaster in satisfying the third requirement of adequate fixation. Immobilization was generally maintained for 6 to 8 weeks depending upon the extent of healing shown by x-ray examination, although our results show the average entire compensable time to be 6.62 weeks. In 2 cases the patients were foremen and returned to work in 9 and 16 days respectively, while 2 others returned to light work as watchmen in 2½ and 3½ weeks, with their casts on and still under treatment. The

average length of treatment was about 10 weeks.

Roentgenograms were taken at the time these men were rated by the Industrial Accident Commissions of Nevada or Arizona, usually 3 to 4 months after they had returned to work. Only 2 of the 16 failed to show bony union. The criteria for bony union were complete obliteration of the fracture line, with the proximal fragment showing the same density as the distal. One of the 2 cases of non-union had also a comminuted fracture of the radius and a fractured hamate. After reduction the wrist was held in slight palmar flexion and in a mid position between ulnar and radial deviation with the thumb partially adducted. This would seem to indicate the importance of position in healing of the scaphoid, if it could be shown that position alone brings as high a percentage of bony union. We have had experience with only one old non-union of a scaphoid. This was seen by one of us in private practice.

The patient, one year after the original injury, complained of a painful wrist. He was doing his regular work, but felt that he could not do it as well as he had previously. Tenderness and slight swelling were present in the anatomical snuff box and x-ray films showed a fracture of the proximal third of the scaphoid with some cystic rarefaction about the site of the fracture. The apposition and alignment of the fragments were good. After the method described by Haldeman and Soto Hall, horizontal incision was made over the scaphoid which was exposed. Several drill holes were made through the fragments, the wound was closed, and a non-padded plaster cast was applied with the wrist in the dorsal ulnar position. This cast was left on for 14 weeks and the patient was returned to light work 2

# ACUTE FRACTURES OF THE CARPAL SCAPHOID

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**I**n handling a large number of fractures during the construction period at Boulder Dam we were quite interested in observing that our percentage of fractures of the carpal scaphoid was high as compared to other bony injuries about the wrist. The statistics regarding the percentage of these fractures reported by other authors have varied considerably, but we feel that our statistics may be considered as typical for purely industrial practice.

A comparison of fractures of the carpal scaphoid with other more common fractures is given here with carpal scaphoid 17, humerus 25, radius 63, clavicle 16, femur 21, tibia 85, fibula 78, os calcis 43.

The literature on this subject is somewhat disconcerting. Crayner, reporting on fractures of the carpal scaphoid, states that non union is very prone to occur in fractures through the waist, while fractures through the tuberosity are of relatively little importance. Murray states that fractures of the tuberosity always unite satisfactorily and that fractures through the waist if immobilized early, will also give satisfactory results. Both of these authors are inclined to believe that non union is due to delayed immobilization. Boehler also reports satisfactory results with immediate fixation. Hosford agrees with the above authors on the results obtained with immediate immobilization, except he states that fractures through the proximal third of the bone have a tendency to non union due to the interference with the blood supply. Scudder is more radical recommending total excision of the involved bone whenever there is a comminuted fracture. When immobilization without open reduction is done it is generally advised that this immobilization be maintained for a period of 6 to 8 weeks. Almost all positions have been advised for the immobilized wrist. Boehler recommends dorsal ulnar flexion. Speed recommends a slight volar and radial flexion and Soto Hall and Haldemann advise a dorsal radial position. As far as reported results are concerned it is difficult to arrive at any definite conclusions because of the fact that the final results are not uniformly rated but are merely said to be good, fair or poor. This type of information is not always helpful.

From the Injury Service, Six Companies Hospital, Boulder City, Nevada

## DIAGNOSIS

The history of these cases is that of a fall on the hyperextended hand with resultant pain and some swelling in the wrist at the base of the first metacarpal. It can be unequivocally stated that any painful or so called sprained wrist occurring after a fall on the outstretched hand should always be x-rayed. On physical examination we have almost always found tenderness and occasionally swelling in the anatomical snuff box. Motion of the wrist is not limited except by moderate pain. Many authors have reported that the diagnosis is confirmed by percussion on the head of the second metacarpal when the fist is clenched. This is supposed to elicit pain in the region of the scaphoid. Rankin we have never used this test and have always found the diagnosis to be easy enough provided the possibility of such a fracture has been considered.

It has also been mentioned frequently that the x-ray is not infallible. It is particularly misleading when one simply has an anteroposterior view and a lateral view made such as one would desire for a possible Colles fracture. It is advisable to take at least one view with the wrist ulnar deviated and in questionable cases, a stereoscopic view should be taken with the wrist in this position. Some roentgenologists advise the use of a magnifying lens when studying these films. Wet films should never be used in determining the presence of these fractures. In the final analysis we believe that if the physician calls the attention of the roentgenologist to the possibility of a fractured carpal scaphoid these fractures will not be missed frequently on the x-ray plate.

## TREATMENT

The results of treatment of any fracture are enhanced by (1) early recognition (2) early treatment and (3) adequate immobilization for a sufficient time to allow healing. Because of the nature of cancellous bone (its location, structure and blood supply) when fractured it is difficult to obtain healing and these factors assume increased importance.

We have nothing new to offer in treatment but only wish to emphasize the important part early treatment has played in our results. Because of an ideal setup for medical care at Boulder Dam our patients were almost always seen within the

immobilization in the accepted position with unpadded plaster for 7 to 8 weeks, one can expect no total permanent disability and  $87\frac{1}{2}$  per cent of bony union

These results in acute fractures and in the one old case of non-union which we report, plus the numerous other excellent results obtained in the treatment of old non-unions by drilling or grafts, we believe should definitely contra-indicate excision of the carpal scaphoid under any condition

#### CONCLUSIONS

- 1 Immediate immobilization is stressed.
- 2 Failure of bony union occurred in only 2, or  $12\frac{1}{2}$  per cent of the acute fractures.
- 3 Disability ratings in the acute fractures, including the 2 cases lacking bony union, have been uniformly zero

#### BIBLIOGRAPHY

- 1 ADAMS, J D, and LEONARD, R D Fracture of the carpal scaphoid New England J Med, 1928, 198 401-404

- 2 ANDERSON, R L Injuries to the carpal bones of the wrist Virginia M Month, 1930, 57 381-383
- 3 BOEHLER, L The Treatment of Fractures P 247 Baltimore William Wood & Co, 1935
- 4 BURNETT, JOSEPH H Further observations on treatment of fracture of the carpal scaphoid (navicular) J Bone & Joint Surg, 1937, 19 1099-1109
- 5 CRAVENER, E K Fracture of the carpal scaphoid New York State J Med, 1935, 35 807-809
- 6 FAULKNER, D M Bipartite carpal scaphoid J Bone & Joint Surg, 1928, 10 284-289
- 7 HOPKINS, FREDERICK S Fractures of the scaphoid in athletes New England J Med, 1933, 209 687-690
- 8 HOSFORD, J P Prognosis in fractures of the carpal scaphoid Proc Roy Soc Med, 1931, 24 92-94
- 9 MUMFORD, E B Fracture of the navicular bone J Indiana State Med Ass, 1929, 22 56-58
- 10 MURRAY, D W GORDON Fractures of the carpal scaphoid Canadian M Ass J, 1936, 34 180-182
- 11 NITSCHKE, F Zur Behandlung der Karpinbeinbrueche Zentralbl f Chir, 1937, 6 323-324
- 12 SCUDDER, C L The Treatment of Fractures P 448 Philadelphia W B Saunders Co, 1936
- 13 SOTO-HALL, RALPH, and HALDEMAN, KEENE O Treatment of fractures of the carpal scaphoid J Bone & Joint Surg, 1934, 16 822-828



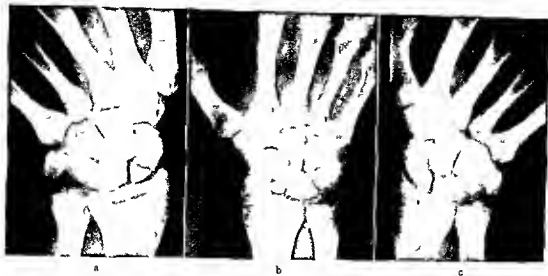


Fig. a Non union of fracture 1 year old. b Appearance 10 weeks and c 30 1/2 weeks after drilling. Patient's wrist was in non padded plaster 14 weeks and he was away

from work 16 weeks. No disability. Note fracture line disappearing and the gradual return of blood supply as evidenced by decreasing density of the proximal fragment.

weeks later. Bony union was partially completed when the last roentgenogram was taken 6 1/2 months after the operation. The patient has full range of motion of the wrist and has no subjective complaints.

#### RESULTS

From a practical standpoint the results were perfect in all cases, since there was a normal range of motion without pain and with full strength of the wrist when these men were rated. Uniformly there was no permanent disability awarded. The average time lost from work was 6.6 weeks, which is less than we would allow for any individual case without the exceptions here noted.

In sharp contrast to the conservative treatment, we present one case treated in the hospital by another surgeon. In this case radical excision of the fragments was done. This patient was on total temporary disability for 8 weeks and returned to a foreman's job requiring only moderate use of the hand. Eventually he was rated at a 35 per cent loss of function of the hand.

It is difficult to compare the results offered by different authors because of their various ways of reporting such results. We believe that inasmuch as the majority of these cases are industrial, are treated by industrial surgeons and are finally rated by industrial accident commissions, they should be reported by the disability rating awarded. This in turn would make these reports a basis for both the insurance carriers and the industrial surgeons to use in making a preliminary

estimate of possible resultant disability in any particular type of fracture. We realize that different accident commissions and medical referees will report in different degree on the same disability. But in general we believe that experienced commissions and referees will not vary appreciably in their decisions. We also realize that in fractures of bones when considerable variation in the type of injury may occur, the disability will vary accordingly.

In a previous paper, however, which considered fractures of the os calcis, we attempted to show that the type of injury and fracture may be so classified that a fairly accurate idea of the resulting disability could be estimated upon a preliminary examination of the injury and of the first roentgenograms, provided a certain line of treatment were carried out. Fractures of the carpal scaphoid are not so varied as to require any classification. Although we know that we may obtain fractures of the tuberosity, fractures of the waist and fracture dislocation of the scaphoid, we find no need to classify these separately because the results with proper and immediate treatment have been uniformly good. Where poor results are obtained, namely painful non union, we are inclined to believe that they were caused by delayed immobilization as a result probably of delayed diagnosis.

The economic value of this survey means that for any individual case, with early recognition and

immobilization in the accepted position with unpadded plaster for 7 to 8 weeks, one can expect no total permanent disability and  $87\frac{1}{2}$  per cent of bony union

These results in acute fractures and in the one old case of non-union which we report, plus the numerous other excellent results obtained in the treatment of old non-unions by drilling or grafts, we believe should definitely contra-indicate excision of the carpal scaphoid under any condition

#### CONCLUSIONS

- 1 Immediate immobilization is stressed.
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- 2 ANDERSON, R L Injuries to the carpal bones of the wrist Virginia M. Month, 1930, 57 381-383
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- 10 MURRAY, D W GORDON Fractures of the carpal scaphoid Canadian M Ass J, 1936, 34. 180-182.
- 11 NITSCHKE, F Zur Behandlung der Kahnbeinbrueche Zentralbl f Chir, 1937, 6 323-324
- 12 SCUDDER, C L The Treatment of Fractures P 448 Philadelphia W B Saunders Co, 1936
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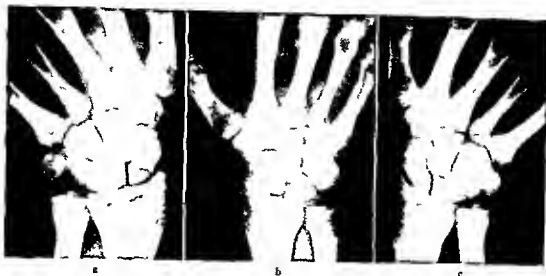


Fig 2 a Non union of fracture 1 year old b Appearance 10 weeks and c 30½ weeks after drilling Patient's wrist was in non padded plaster 14 weeks and he was away

from work 16 weeks No disability Note fracture line disappearing and the gradual return of blood supply as evidenced by decreasing density of the proximal fragment

weeks later Bony union was partially completed when the last roentgenogram was taken 6½ months after the operation The patient has full range of motion of the wrist and has no subjective complaints

#### RESULTS

From a practical standpoint the results were perfect in all cases since there was a normal range of motion without pain, and with full strength of the wrist when these men were rated Uniformly there was no permanent disability award The average time lost from work was 6.62 weeks which is less than we would allow for any individual case without the exceptions here noted

In sharp contrast to the conservative treatment we present one case treated in the hospital by another surgeon In this case radical excision of the fragments was done This patient was on total temporary disability for 5 weeks and returned to a foreman's job requiring only moderate use of the hand Eventually he was rated at 75 per cent loss of function of the hand

It is difficult to compare the results offered by different authors because of their various ways of reporting such results We believe that inasmuch as the majority of these cases are industrial are treated by industrial surgeons and are finally rated by industrial accident commission they should be reported by the disability rating awarded This in turn would make these reports a basis for both the insurance carriers and the industrial surgeons to use in making a preliminary

estimate of possible resultant disability in any particular type of fracture We realize that different accident commissions and medical referees will report in different degree on the same disability But in general we believe that experienced commissions and referees will not vary appreciably in their decisions We also realize that in fractures of bones when considerable variation in the type of injury may occur the disability will vary accordingly

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The economic value of this survey means that for any individual case with early recognition and

tion is insignificant in relation to the surgical aspects of this entity. In this series corpus luteum cysts comprised 75 per cent of cases and the follicle cysts 25 per cent.

#### SURGICAL PATHOLOGY

The occurrence of intraperitoneal hemorrhage arising from ovarian retention cysts is now well established. The usual findings of a gross tear or rupture in the wall of these cysts explain in most cases the origin of the hemorrhage. In such instances the cyst cavity usually contains blood which may be clotted and around which a small steady ooze or a larger spurting vessel may be found. In some cases it is impossible to demonstrate the vessel from which the bleeding occurs, and the opening on the surface of the ovary may be so minute as to leave one in doubt as to the ovarian origin of the intraperitoneal hemorrhage. This is not surprising since nature attempts to wall off the troublesome area and lay down a zone of fibrin so as to close the point of hemorrhage.

VerBruggen reports a case of massive intraperitoneal hemorrhage wherein at operation he found a small bleeding point on the right ovary. Although the abdominal cavity was thoroughly explored, no other point of hemorrhage could be found. The surgeon in this instance felt that the minute point of hemorrhage in the ovary did not explain the massive intraperitoneal bleeding. In 2 of our patients, one of whom was almost exsanguinated, no point of rupture could be seen although the assumption was made that the hemorrhage came from a cystic ovary filled with blood. It was removed and the pathologist proved it to be the source of the hemorrhage although he was unable to demonstrate a point of rupture. Apparently a massive intraperitoneal hemorrhage may take place as the result of a small tear in one or the other type of ovarian retention cysts, and no point of rupture may be demonstrable even by microscopic examination.

Emil Novak states that the occurrence of hemorrhage will depend largely on the location of the rupture of the cyst structures in relation to its blood vessels. If they lie near the surface when it ruptures, an extensive hemorrhage will then result, whereas a rupture in a relatively avascular area might produce very little bleeding. Our series confirms this statement.

Occasionally, these cysts may produce an abnormal type of vaginal bleeding which is on a hormonal basis. We refer to the vaginal spotting which is sometimes seen and simulates the spotting associated with ectopic pregnancy. Such bleeding is most likely explained on the basis of

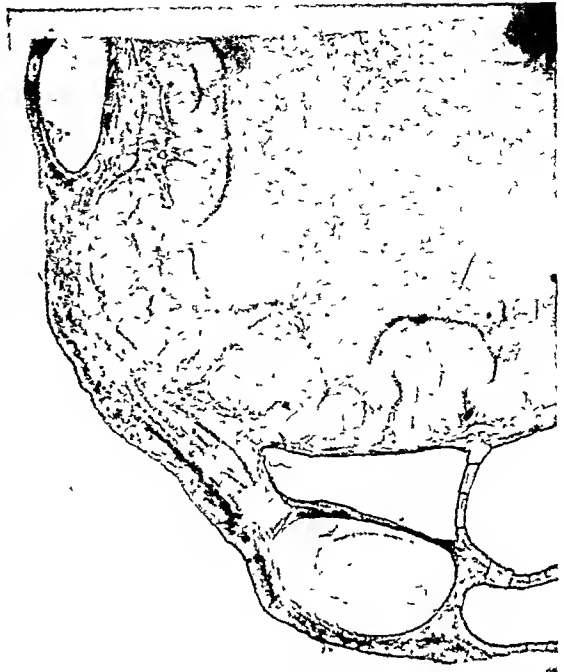


Fig 1. Photomicrograph of graafian follicle cyst removed from Case 2, Mrs. B.L. Section shows multiple follicle cysts without hemorrhage and a large central cyst filled with blood. This larger cyst had ruptured producing a moderate hemorrhage simulating acute appendicitis.

an excess of estrin secreted by the abnormal cyst. There is proof offered by various writers that a follicle cyst may secrete an excess of estrin (7, 8). One of the actions of estrin is to produce an increased vascularity of the uterine endometrium which may produce continuous spotting. This was noted in 4 of our cases and suggested tubal pregnancy. In one of the cases the spotting continued following the resection of the cyst but stopped on the administration of prolan in the form of antuitrin-S.

#### THEORIES AS TO MECHANISM OF RUPTURE

In discussing the mechanism of rupture in these cysts, the question arises as to whether spontaneous intracystic bleeding is a forerunner to rupture, or whether bleeding is the result of rupture produced by other extracystic factors. Theoretically, it is conceivable that hormonal influences might play a part in the production of spontaneous bleeding into these cysts. The general increased vascularity of the pelvic organs at such a time may easily explain the intracystic hemorrhage and subsequent rupture. The occurrence during sound sleep of a rupture, which is not infrequent, can be

# INTRAPERITONEAL HEMORRHAGE FROM RUPTURED OVARIAN RETENTION CYSTS

## Corpus Luteum and Graafian Follicle Cysts

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**D**URING the last few years rupture of ovarian retention cysts has received more frequent recognition in the differential diagnosis of acute surgical abdominal conditions. The consideration of this diagnosis as to its importance had not been emphasized previously. The description of characteristic clinical symptoms produced by a rupture of an ovarian retention cyst is difficult to find in any text book or current surgical literature. Cope, in his excellent and adequate work on the diagnosis of the acute abdomen, does not mention this subject. Individual case reports are frequently noted and a few papers have appeared covering larger series. To date a total of 367 cases have been reported in the literature. This condition is not the rarity it was formerly thought to be but its recognition and pre-operative diagnosis still remain difficult.

In an attempt to classify the clinical picture of this surgical entity the authors have reviewed a series of 45 patients with ruptured ovarian retention cysts who were admitted to the surgical service of the Mount Zion Hospital during the years 1926 to 1938. The study of this group of cases has shown remarkable variations in the pathology, the clinical diagnostic features and the etiology. The one characteristic feature of all these cases, however, has been the constant finding at operation of intraperitoneal hemorrhage in varying amounts. It is our belief that the variations in the pre-operative picture are directly dependent upon the severity and degree of intraperitoneal bleeding and that a clinical classification with adequate features may be described on this basis.

### PHYSIOLOGY AND PATHOLOGY

To understand properly the clinical course of a ruptured ovarian retention cyst it is essential to review briefly the normal physiology of ovulation and the deviations which result in pathological ovarian cyst formation. Without attempting to

describe the minute histology of the ovary it is sufficient for our purposes to review the normal sequence of events connected with ovulation. The ovarian stroma contains an innumerable number of primordial cells which vary greatly in degree of maturity. As an individual ovum matures it is seen to be deeply situated within a cyst like structure lined by granulosa cells first described by de Graaf and now referred to as a graafian follicle. It is generally considered that during the middle of the menstrual cycle the matured graafian follicle ruptures to expel the ovum. The follicle fills with blood and fibrin and the granulosa cells are transformed to large luteal cells as organization proceeds. Later the corpus luteum shrinks in size and terminates as an orange pigmented scar.

The graafian follicle and corpus luteum found in this normal process are minute structures hardly visible to the naked eye and it is improbable that clinical disturbances of surgical significance are produced in this cycle. If hypersecretion into the graafian follicle occurs at some stage in its development, a pathological condition results which produces an abnormal enlargement of the follicle so that there occurs a cyst formation which has been called a graafian follicle cyst. Failure of the corpus luteum to regress and disappear might likewise result in the formation of a cyst which is referred to as a corpus luteum cyst. In such a cyst the wall may be 1 to 3 centimeters in thickness so that the cavities vary proportionately. Occasionally the ovary may be completely replaced by the cyst although a small nodule of ovarian parenchyma remains near the pedicle.

Basically both these types of cyst have the same origin. Microscopically they differ slightly in their structure. For simplicity in their clinical classification as well as to describe their common origin, they may be referred to as ovarian retention cysts. (5) We advocate the use of this terminology for clinical discussion on this subject. There appears to be considerable confusion in the literature in reporting these cases as to whether the author is describing a rupture of a corpus luteum or graafian follicle cyst. This difference

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On examination one is impressed by the fact that these patients do not appear sick. There is no change in the pulse or temperature. Muscle guarding may be present but is not well defined or constant, and true rigidity is never seen. Tenderness is present at some time during repeated examinations on such a patient but may be absent at other times. It is not pronounced and when felt is always in the lower abdomen. Auscultation of the abdomen shows normal or slightly increased peristalsis.

Pelvic examination may occasionally show the presence of a small cystic protuberance in one or the other ovary. When such positive findings are present and the patient is conservatively treated, check-up examination after the disappearance of the symptoms may reveal normal ovaries with no evidence of the cyst previously noted.

The blood count in the mild cases usually shows essentially normal findings. No anemia is noted and leucocytosis is not the rule although an occasional case has shown a rise in the white blood count to as high as 15,000.

#### GROUP 1: ILLUSTRATIVE CASES OF MILD HEMORRHAGE

Mrs S N (No 22834), age 24 years, entered the hospital on April 9, 1936. She was complaining of pain in the lower abdomen of 4 days' duration. The pains were described as being originally referred to the pit of the stomach and were not severe. The last 2 days they had centered in the lower abdomen. There was no history of vomiting but she had noticed occasional slight nausea. Her last menstrual period was approximately 2 weeks before on March 23, 1936.

Examination showed a patient apparently not sick looking, temperature 37 degrees C, pulse 80. On examination of the abdomen there was found tenderness in both lower quadrants. No rigidity was found but there was slight muscle guarding present. There was no distention of the abdomen and peristalsis was active. A pelvic examination showed tenderness in both fornices but no masses were palpable.

*Laboratory work* White blood count, 10,400, polymorphonuclears, 69 per cent, hemoglobin, 79 per cent, red blood count, 4,200,000.

A tentative diagnosis of subacute appendicitis was made. At operation approximately 100 cubic centimeters of blood tinged fluid was found in the pelvis and there was a cystic right ovary with a rupture of a small cyst about the size of a cherry which was still oozing blood. The appendix was essentially negative.

This case illustrates a time interval of 4 days from onset of the pain to the time she sought medical advice. The persistent indefinite abdominal pains made the surgeon suspicious of appendicitis. The onset of her pain, approximately 2 weeks after her last period, suggests that it was a rupture of a follicle cyst, although the surgeon described it as a ruptured corpus luteum cyst. The common error of diagnosing subacute

appendicitis is also illustrated by this case. Had the exact diagnosis been made the patient would probably not have needed surgery.

Mrs O M, age 23 years, entered the hospital on November 14, 1937. She stated that immediately following the act of defecation early that morning she was seized with a cramp-like pain that doubled her up. This pain lasted about 1½ hours and was located deep in her lower abdomen. There was no nausea, no vomiting, nor had she felt faint or dizzy. Her last menstrual period was about 3 weeks previous. She stated that she expected to menstruate in a few days.

Examination showed a patient who did not appear sick, temperature, 37 degrees C, pulse 96. The abdomen showed tenderness in the right lower quadrant and suggestive rebound tenderness over McBurney's point. There was moderate muscle guarding but no true rigidity and peristalsis was very active. Pelvic examination showed a suggestive tender cystic mass in the right fornix.

*Laboratory work* White blood count, 7,300, polymorphonuclears, 79 per cent, red blood count, 3,860,000.

*Subsequent course* In 36 hours the abdominal pains completely disappeared. The patient was discharged from the hospital with a diagnosis of a ruptured corpus luteum cyst. She was examined in the physician's office 10 days later and the cystic mass noted in the right fornix had disappeared although the ovary could be easily palpated.

This case illustrates the suddenness with which the onset of the pain appeared in relation to the act of defecation, suggesting a rupture of a retention cyst. Because of the proximity of her next menses the cyst was probably a corpus luteum. She was treated conservatively with complete relief and the disappearance, on subsequent pelvic examination, of the cystic mass found during the acute attack.

*Group 2* The onset of pain is not unlike that described in Group 1, and bears a similar relationship to the menstrual cycle. Usually there is a history of sudden sharp pain in the lower abdomen but the duration following the onset is longer. Although there may be a cessation of symptoms for a period of hours, the return of pain within a short time is the rule. The pain is more definitely localized to either the left lower quadrant or the right lower quadrant and simulates more closely the pain of acute appendicitis, particularly pelvic appendicitis, when localized to either the left lower quadrant, as Brunn has so well described. On continued observation the pain shifts to the upper quadrant of the abdomen but is not colicky in nature and is described as a severe discomfort. Seldom is a narcotic required. When questioned many of these patients will recall or complain of pain in one or the other shoulder which is pathognomonic of the presence of sufficient blood to cause diaphragmatic irritation. Nausea is noted as frequently as in Group 1, and vomiting is occasionally present but is not noteworthy. Symptoms of mild shock are noted in many



Fig. 2 Drawing from specimen removed at operation from Case 32 Mrs. S. R. Pre operative diagnosis of ectopic pregnancy. Drawing shows point of hemorrhage that is sealed over by fibrin and a large thick walled corpus luteum cyst which grossly simulated an ovarian pregnancy.



Fig. 3 Photomicrograph of specimen shown in Figure 2. The corpus luteum is a thick walled cyst with the center of the cyst filled with old and recent hemorrhage. There is moderate edema of the ovarian stroma.

explained only on the basis of spontaneous intracystic bleeding. This has been noted in this series as well as in other reports.

In the majority of these cases however, there is usually a history which suggests a more than casual relationship to some exciting traumatic factor. Most authors have therefore, assumed that the rupture precedes and is the cause of the bleeding. Our series demonstrated a high percentage of the cases wherein the history suggests extracystic factors of the type of direct or indirect trauma.

In this category we place cases which are antedated in the occurrences of their symptoms by a history of (1) a pelvic examination (2) a direct blow on the abdomen (3) coitus (4) straining at stool lifting heavy objects and vomiting as examples of increased intra abdominal pressure (5) acute appendicitis and appendiceal colic are occasionally etiological factors probable on the basis of the pain associated with these conditions increasing intra abdominal pressure.

#### CLINICAL ASPECTS

The degree of intraperitoneal hemorrhage determines the characteristic clinical features of this condition. This study of 45 cases suggests the division for descriptive purposes into 3 groups (1) those suffering from mild hemorrhage by which is meant the finding at operation of an amount of blood or blood tinged fluid of less than 100 cubic centimeters (2) those suffering from moderate hemorrhage amounting to between 100 and 500 cubic centimeters and (3) those suffering from massive hemorrhage of from 500 to as much as 1500 cubic centimeters.

*Group 1* is characterized by mild intraperitoneal bleeding with minimal symptoms. In this group the pain is extremely variable and depends on various factors. There may be a history of a sudden sharp pain of momentary duration in either the right lower quadrant or the left lower quadrant which is due to the actual rupture of the cyst. This momentary pain may be followed by complete relief. A few hours to a few days later there may be noted the appearance of vague lower abdominal pains which are fleeting and ill defined. The patient is not sick enough to be confined to bed but has a definite feeling of discomfort in the lower abdomen. These patients are often admitted to the hospital for observation on suspicion of a possible acute surgical abdomen and are discharged within 24 to 72 hours because of lack of further positive findings. Occasionally they are returned in another 48 to 72 hours for exploratory operation due to the persistence of these vague abdominal pains. Shoulder pain has not been noted in this group. Nausea of mild degree is occasionally present but vomiting is seldom seen. Symptoms of mild shock are absent.

The history of the onset of these symptoms can always be traced to a definite relationship with the menstrual cycle and is of the utmost significance. Pain occurring in the lower abdomen at or after the middle of the intermenstrual period suggests probable follicular origin. Pain appearing just preceding the onset of the menses is due to hemorrhage from a corpus luteum cyst.

with maximum tenderness in the lower abdomen. Muscle guarding is definite but no rigidity is noted. Peristalsis in this advanced bleeding type may also be absent. On percussion of the abdomen a definite area of dullness may be noted in the lower part. Pelvic examination will show fluctuation in the cul-de-sac suggestive of fluid which is easily interpreted as being blood in view of the general appearance and condition of the patient. The blood count is of help in these cases as it shows a definite drop in hemoglobin and an increase in leucocytes.

### GROUP 3: ILLUSTRATIVE CASES OF MASSIVE HEMORRHAGE

Miss T. G. (No. 22143), age 18 years, single, entered the hospital on September 18, 1935, complaining of an attack of sudden severe pain in the right lower quadrant of her abdomen which had increased in severity over the past few hours. She had a severe pain in her right shoulder and some upper abdominal discomfort. The patient had not vomited but was nauseated.

On examination the patient definitely appeared sick, pale, and worried; temperature, 37.3 degrees C, pulse, 98. There was noted some moderate distention and generalized, extreme tenderness in both lower quadrants of her abdomen which was dull to percussion and on auscultation no peristalsis was heard. Rectal-pelvic examination revealed tenderness in the cul-de-sac and the suggestion of a mass. Her last period was 3 weeks previous. During about 6 hours' observation the patient's pulse became more rapid and she showed more pronounced symptoms of shock.

**Laboratory work:** Hemoglobin, 50 per cent, red blood count, 3,650,000, white blood count, 12,500.

A tentative diagnosis of ruptured ovarian retention cyst with massive intraperitoneal hemorrhage was made. At operation over 1,000 cubic centimeters of blood was aspirated from the peritoneal cavity and retransfused into the patient. A cystic mass, the size of a small orange completely filled with clotted blood and representing a hemorrhage into a corpus luteum cyst of the right ovary, was removed. The patient made an uneventful recovery.

This case illustrates the severe type of hemorrhage that may occur as the result of a comparatively small tear or rupture in an ovarian retention cyst. Although a massive hemorrhage was found it was difficult to demonstrate either macroscopically or microscopically the exact point of rupture. The variability of the abdominal pains, its complete disappearance and reappearance at intervals, as well as frequent change in location, are characteristic.

### DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS

This condition occurs in women of the second and third decades of life. No single feature or symptom is characteristic but its variable manifestations strongly suggest the diagnosis. The variability of the abdominal pains, their complete disappearance and reappearance at intervals, as well as frequent changes in location, are charac-

teristic. The initial pain may be severe although momentary and may be associated with trauma. Even without a history of trauma this pain may be of such severity as to awaken a patient from sound sleep. When the pain reappears later it is changed in character, it is dull, described as an abdominal discomfort, it is not colicky and seldom requires a narcotic. *The pain is sufficient to put both the doctor and the patient on guard but is insufficient to clearly define the type of pathology that is within the abdomen*, unless one has a "high index of suspicion." Many of the minor attacks of unexplained abdominal pains in female patients are probably on the basis of mild intraperitoneal bleeding. The abdominal tenderness present in these patients is as variable in its degree and location as the symptoms of pain. When found in the lower abdomen it is usually at a low level close to Poupart's ligament. Muscle guarding is present in proportion to the peritoneal irritation because of bleeding. Rigidity is seldom seen. Hyperactive peristalsis is an important accessory diagnostic finding.

Rupture of an ovarian retention cyst is most frequently diagnosed as acute appendicitis. This was the pre-operative diagnosis in 54 per cent of our series. Hoyt and Meigs report a similar diagnosis in 56 per cent of their cases. The onset of the pain in ruptured cysts is usually sudden and momentary, compared to the gradual and constant pain of appendicitis. The variability in duration and variation in location of the abdominal pain is unlike the steady and more definite location of appendicitis. On abdominal examination tenderness may be elicited only over the right lower quadrant and strongly suggests appendicitis. It later tends to shift to other parts of the lower abdomen more frequently than is seen in appendicitis. With increased bleeding abdominal tenderness becomes more generalized. *Even when the tenderness remains located in the right lower quadrant, careful examination will disclose that tenderness is just above the inguinal region in contrast to the periumbilical or McBurney tenderness of appendicitis.* The total white blood count and in particular the differential polymorphonuclear count are higher as a rule in acute appendicitis.

The next most frequent mistake in the diagnosis of this condition is its confusion with ruptured ectopic pregnancy. The occasional presence of continued vaginal spotting associated with retention cysts is probably due to an excess of estrin derived from the cyst and might lead to an erroneous diagnosis of ectopic pregnancy. The occurrence of massive hemorrhage with signs and symptoms of shock further confuses the picture. Differentiation in such cases depends on a careful



patients and are characterized by dizziness, faintness, and a feeling of weakness. These symptoms are particularly pronounced if the patient has been ambulatory.

On examination these patients appear worried and somewhat sick looking. No noticeable alteration in pulse or temperature is observed. Abdominal tenderness, however, is a constant finding. It is limited to the lower abdomen but shifts to the upper quadrants frequently. This shifting tenderness is strongly suggestive of moderate intraperitoneal bleeding. The tenderness may be quite exquisite, particularly in the inguinal regions. To the experienced surgeon it is not, however, the abdominal tenderness of an acute infectious peritonitis. Muscle guarding is pronounced and in most of these cases may even suggest true surgical rigidity. On auscultation peristalsis is very active and will help in differentiating from the silent abdomen of more serious conditions. Pelvic examination may or may not reveal a palpable cystic mass in either one ovary or the other. Occasionally, however, a doughy fullness may be felt in the cul de sac suggestive of an accumulation of blood or blood clots. The blood count is quite variable with a greater tendency to leucocytosis. No change is noted in the hemoglobin of sufficient importance to be of clinical value.

#### GROUP 2 ILLUSTRATIVE CASES OF MODERATE HEMORRHAGE

Mrs M. F. age 30 years a graduate nurse entered the hospital on January 20, 1935, stating that early that morning she was awakened from her sleep by a sharp severe pain in the lower abdomen which seemed more intense in the right lower quadrant. She became very nauseated but did not vomit. Her last menstrual period was approximately 3 weeks previous.

On examination the patient appeared sick and worried. Temperature 37.1 degrees C. pulse 84. The abdomen showed no rigidity but there was marked tenderness over the entire abdomen particularly more pronounced over McBurney's point. Auscultation showed very active peristalsis. There was mild muscle guarding over the entire abdomen.

*Laboratory work:* White blood count 7,430 polymorphonuclears 68 per cent.

After 24 hours observation the clinical picture had not changed. The abdominal pains although varying considerably in severity were still present. As her tenderness seemed definitely localized to the right lower quadrant a diagnosis of acute appendicitis was made and surgery advised. Operation was performed through a McBurney incision and when the peritoneum was opened a considerable amount of bright red blood was found. A normal appendix was quickly removed through this incision and it was then closed and a midline incision made. On exploration of the abdomen approximately 500 cubic centimeters of bright blood was seen and a ruptured cyst the size of a walnut was found still oozing blood from the left ovary. The cystic portion of the left ovary was resected and plastic

closure of the remaining stroma made with interrupted silk sutures. The patient's convalescence was uneventful.

This case illustrates a more severe type of pain simulating appendiceal colic. The diffuseness over the abdomen on continued observation and the active peristalsis without a rise in temperature or white blood count after 24 hours should have made one suspicious that the diagnosis was not acute appendicitis.

Mrs M. O. age 35 years a housewife was seen at home on November 27, 1936. Of interest in her past history is that she had her appendix removed at the age of 15. The patient stated that for the past 3 days she had had indefinite pains in her lower abdomen which were similar in nature to the pains she remembered having during her attack of appendicitis a few years previous. She said the pain disappeared and reappeared and in the last 24 hours had increased in severity so that she felt it advisable to remain in bed. She also complained of slight dizziness and weakness when she was on her feet. On direct questioning she complained of pain in her right shoulder.

Abdominal examination showed a soft abdomen with tenderness in all quadrants particularly in the right lower quadrant. There was no rigidity nor muscle guarding and active peristalsis was heard. Pelvic examination showed the right ovary to be enlarged with a suggestion of a small cystic mass attached to it which was very tender. Her last menstrual period was 2 weeks previous.

A tentative diagnosis of a ruptured follicle cyst was made and the patient was advised to remain in bed with ice packs to the lower abdomen. She made a complete recovery in about 3 days and reported to the office for a check up pelvic examination on December 14, 1936 at which time no evidence was found of a cystic mass attached to the right ovary nor was any tenderness present.

This case illustrates a classical picture of a ruptured follicle cyst. The previous removal of her appendix aided in the diagnosis. Characteristic right shoulder pain suggestive of moderate intraperitoneal hemorrhage and the finding of a cystic mass connected to the right ovary which disappeared over the subsequent period of observation was further confirmation. Such a case affords one who has a high index of suspicion a fine opportunity of studying the progress of ruptured ovarian retention cyst under conservative management.

**Group 3:** These patients show signs and symptoms which are typical of massive intraperitoneal hemorrhage. They constitute the smallest percentage. The onset of the pain is definitely more severe and constant in its character. There is no period of relief rather an increase in its severity. The pain is localized across the entire lower abdomen but in a few hours it involves the upper abdomen and there is characteristic pain in either one or the other shoulder. Nausea is more frequently seen as well as vomiting. These patients show definite evidence of shock which may be profound. Abdominal tenderness is generalized

clinical aspects of this entity are determined by the amount of intraperitoneal bleeding

4 The mechanism of rupture may be due to increased intracystic pressure from spontaneous bleeding into the cyst, or increased extracystic pressure from trauma of various types.

5 The diagnosis of the condition is dependent upon time relation to the previous menstruation, characteristic variation in abdominal pain and tenderness, the presence of active peristalsis, and frequently positive pelvic findings. A "high index of suspicion" aids materially in the diagnosis.

6 Rupture of an ovarian retention cyst must be differentiated from (1) acute appendicitis, (2) ectopic pregnancy, (3) pelvic inflammatory disease, and (4) torsion of an ovarian cyst.

7 The majority of these cases can be treated by conservative observation after the proper diagnosis is made. The tendency to recurrent attacks is rare but does occur, and the possibility of treatment by endocrine therapy is suggested in such cases.

8 Rupture of ovarian retention cysts seems to have a high incidence among nurses.

9 When surgical intervention is necessary, the entire ovary should not be sacrificed. Plastic resection of the cyst and preservation of normal ovarian tissue is advocated.

## BIBLIOGRAPHY

- 1 BOORMAN, M. R. Report of case of rupture of corpus luteum with intraperitoneal hemorrhage. *Am J Obst*, 1914, 70: 416.
- 2 BRUNN, HAROLD. Acute pelvic appendicitis. *Surg, Gynec & Obst*, 1936, 63: 583.
- 3 COPE, Z. The early diagnosis of the acute abdomen. Oxford Univ Press, 1935.
- 4 ECKLES, B. F. Abdominal hemorrhage of ovarian origin. Case report. *Virginia M Month*, 1929, 56: 371.
- 5 GOODALL, J. R. Pathology of cysts and tumors of ovary. Nelson Loose-Leaf Living Surgery, Vol 7.
- 6 HOYT, W. F., and MEIGS, J. V. Rupture of graafian follicle and corpus luteum cysts. *Surg, Gynec. & Obst*, 1936, 62: 114.
- 7 MAZER, CHARLES, and GOLDSTEIN, L. *Clinical Endocrinology of the Female*. Philadelphia: W B Saunders Co, 1932.
- 8 NOVAK, EMIL. Abdominal hemorrhage of ovarian origin. *J Am M Ass*, 1917, 68: 1160.
- 9 PRATT, J. P. Symptoms from rupture of follicle cyst or corpus luteum. *Am J Obst & Gynec*, 1934.
- 10 PRIMROSE, A. Hemorrhage into the peritoneal cavity caused by accident rupture of the ovary. *Ann Surg*, 1912, 56: 125.
- 11 VERBRUGGHE, A. Hemorrhage from corpus luteum. *Med J Australia*, 1937, Aug 27, p 296.
- 12 WARNSHUIS, F. C. A report of a case of ruptured ovary with large intra abdominal hemorrhage. *Physician & Surg*.
- 13 WITHERSPOON, J. T. The inter-relationship between ovarian follicle cysts, hyperplasia of the endometrium and fibromyomata. *Surg, Gynec & Obst*, 1933, 56: 1026.

analysis of the menstrual cycle. In contrast to ectopic pregnancy there is usually no history of a missed or late period. The use of the urine pregnancy test is of considerable value in differentiation as it always is negative with ruptured cysts, and so frequently positive in ectopic pregnancy.

Occasionally this condition is confused with acute or subacute pelvic inflammation. This differentiation should be easily made because of the absence of high fever and the fact that these patients are not as sick as those with pelvic inflammation. Rigidity is not usually found in this condition. The sedimentation time is always normal in contrast to the rapid sedimentation time of pelvic inflammation.

Twisted ovarian cyst is usually a more sudden and severe emergency which on examination presents a well defined tender pelvic mass the presence of which has usually been known to the patient for some time past.

Endometriosis which clinically is a rather rare entity, may simulate this condition but the close relation of its symptoms to the onset of menstruation should aid in the differentiation.

Treatment will depend largely upon the acuity of the clinician. If a correct differential diagnosis has been made and it is found that the patient is suffering from mild or moderate intraperitoneal bleeding conservative observation is indicated. Such observation necessitates repeated examinations of the patient. With the proper diagnosis is the greater majority of these cases will not need surgical intervention. It is our belief that many of the patients whom we operated upon in our series would spontaneously have stopped bleeding and reabsorbed the intraperitoneal blood. With greater experience and a more careful study of this subject we have found that we are operating less frequently. Pratt has reported a similar experience and recommends conservative observation.

Surgery should be performed if there are signs or symptoms of increasing or massive intraperitoneal hemorrhage, or when the diagnosis remains doubtful after a reasonable period of conservatism. A low midline incision is usually made and if a bleeding cyst is found it is resected and as much as possible of the good ovarian stroma is preserved. The ovary in such cases is usually resutured with fine silk. It is strongly urged that a McBurney incision should not be used in a female when there is any reasonable doubt of the diagnosis of acute appendicitis.

#### REMARKS

In the larger majority of our cases there does not appear to be a tendency to recurrence of this

condition. However, there is a smaller group in which the condition seems to recur at frequent intervals. One of our patients had recurring attacks at every intermenstrual period for 6 consecutive months. These attacks were more definite than the so called 'Mittelschmerz' so frequently described in foreign literature but so infrequently seen in this country. She was given a course of endocrine therapy in the form of emmenin with a remarkable and complete disappearance of her attacks. Such a case suggests the probability that some of the new endocrine preparations may be of value in treatment when the condition is recurrent. In other cases in which the patients had been operated upon and appendectomy performed as well as plastic resection of the affected ovary, the recurrent attack was treated conservatively because of the certainty of the diagnosis. To reoperate upon such a patient might mean the sacrifice of the involved ovary. Our policy has been to err on the side of conservatism and never remove the entire ovary in the young patients.

It is interesting to note that there were 4 patients who had recurring attacks. These were all nurses. Of the total series of 45, 11 of the patients or approximately 25 per cent were nurses. It is possible that their type of work which necessitates long hours in the upright position and often requires lifting of heavy patients may predispose to ruptured cysts. Certainly the high incidence among nurses should be emphasized in relation to diagnosis.

The occurrence of proven appendicitis in 6 cases of this series in conjunction with a ruptured cyst is of interest. This finding has been noted in other reports (2, 6, 9, 10). One can theorize that the cyst rupture is a secondary and incidental accompaniment of the appendix attack and probably would not have occurred otherwise. There must be an increase in intra abdominal pressure with the pain of acute appendicitis particularly the obstructive type which produces a rupture of a pre-existing cyst.

#### CONCLUSIONS

1. For clinical purposes the term ovarian retention cyst is advocated in the discussions of rupture of graafian follicle and corpus luteum cysts.
2. Intraperitoneal hemorrhage from rupture of an ovarian retention cyst has not received sufficient recognition in the differential diagnosis of acute surgical abdominal conditions.
3. A classification into 3 groups of mild moderate, and massive hemorrhage resulting from rupture of ovarian retention cyst is described. The

clinical aspects of this entity are determined by the amount of intraperitoneal bleeding

4 The mechanism of rupture may be due to increased intracystic pressure from spontaneous bleeding into the cyst, or increased extracystic pressure from trauma of various types

5 The diagnosis of the condition is dependent upon time relation to the previous menstruation, characteristic variation in abdominal pain and tenderness, the presence of active peristalsis, and frequently positive pelvic findings. A "high index of suspicion" aids materially in the diagnosis

6 Rupture of an ovarian retention cyst must be differentiated from (1) acute appendicitis, (2) ectopic pregnancy, (3) pelvic inflammatory disease, and (4) torsion of an ovarian cyst

7 The majority of these cases can be treated by conservative observation after the proper diagnosis is made. The tendency to recurrent attacks is rare but does occur, and the possibility of treatment by endocrine therapy is suggested in such cases

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#### BIBLIOGRAPHY

- 1 BOOKMAN, M. R. Report of case of rupture of corpus luteum with intraperitoneal hemorrhage. *Am J. Obst.*, 1914, 70 416
- 2 BRUNN, HAROLD. Acute pelvic appendicitis. *Surg., Gynec. & Obst.*, 1936, 63 583
- 3 COPE, Z. The early diagnosis of the acute abdomen. Oxford Univ. Press, 1935
- 4 ECKLES, B. F. Abdominal hemorrhage of ovarian origin. Case report. *Virginia M. Month.*, 1929, 56 371
- 5 GOODALL, J. R. Pathology of cysts and tumors of ovary. Nelson Loose-Leaf Living Surgery, Vol. 7
- 6 HOYT, W. F., and MEIGS, J. V. Rupture of graafian follicle and corpus luteum cysts. *Surg., Gynec. & Obst.*, 1936, 62 114
- 7 MAZER, CHARLES, and GOLDSTEIN, L. Clinical Endocrinology of the Female. Philadelphia: W. B. Saunders Co., 1932
- 8 NOVAK, EMIL. Abdominal hemorrhage of ovarian origin. *J. Am. M. Ass.*, 1917, 68 1160
- 9 PRATT, J. P. Symptoms from rupture of follicle cyst or corpus luteum. *Am. J. Obst. & Gynec.*, 1934
- 10 PRIMROSE, A. Hemorrhage into the peritoneal cavity caused by accident rupture of the ovary. *Ann. Surg.*, 1912, 56 125
- 11 VERBRUGGHEN, A. Hemorrhage from corpus luteum. *Med. J. Australia*, 1937, Aug. 27, p. 296
- 12 WARNSHUIS, F. C. A report of a case of ruptured ovary with large intra-abdominal hemorrhage. *Physician & Surg.*
- 13 WITHERSPOON, J. T. The inter-relationship between ovarian follicle cysts, hyperplasia of the endometrium and fibromyomata. *Surg., Gynec. & Obst.*, 1933, 56 1026

# THE CONSERVATIVE SURGICAL TREATMENT OF NON-CALCULOUS HYDRONEPHROSIS

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**I**NTERFERENCE with the flow of urine from a kidney, which persists for any appreciable length of time, invariably causes some degree of hydronephrosis. The extent of pyelectasis and caliectasis which results varies and depends upon the degree and duration of obstruction, the presence of infection, the status of renal function and other related factors. The conservative surgical procedure which is indicated to relieve symptoms and prevent further damage to the renal parenchyma must be altered according to the exact anatomical relationships that are present.

Many advances have been made during the past 40 years in the conservative surgical treatment of hydronephrosis so that now many kidneys are preserved which previously would have been considered irreparably damaged and removed. As experience with this type of surgery has grown, the results both immediate and ultimate have become increasingly more satisfactory (10). The present discussion will be limited entirely to the conservative surgical management of hydronephrosis. Symptoms, diagnosis, indications for operation, significance of infection and other aspects of the subject will not be discussed. No attempt will be made to discuss the historical development of the conservative surgical treatment of hydronephrosis nor to review the current literature on the subject.

## CAUSES AND SURGICAL PROCEDURES

**Anomalous vessels.** Anomalous blood vessels directed to the lower pole of the kidney constitute one of the abnormalities first described as a cause for hydronephrosis (1-6). For many years the etiological relationship of these vessels to hydronephrosis remained unquestioned. In recent years, however, certain authors have expressed the belief that aberrant vessels of this type are only of secondary importance and are not primarily responsible for the hydronephrosis (11). At present there is therefore some divergence of opinion regarding the importance of these vessels in the production of hydronephrosis. It is certainly true that the mere presence of anomalous vessels to the lower pole of the kidney is of no

definite significance unless it can be clearly demonstrated that they interfere with drainage from the kidney.

Rather than formulate a dogmatic opinion regarding all anomalous vessels it appears more reasonable to judge each case individually. At the time of operation, when actual anatomical relationships can be accurately ascertained, marked variations are noted in different cases. The responsibility for determining the exact factors concerned in the production of the hydronephrosis therefore resides with the surgeon. In some cases there seems to be no possibility that aberrant vessels to the lower pole interfere with drainage from the renal pelvis. In these cases the anomalous vessels are not even in contact with the ureter or pelvis. In other cases it seems equally apparent that these vessels are a definite factor in the production of hydronephrosis although it is realized that their apparent importance may be accentuated as the pelvis gradually increases in size. One may find the ureter sharply angulated or flattened against the pelvis by pressure of the vessels. Active peristalsis may be seen in the pelvis and upper portion of the ureter, but despite this fact the pelvis remains distended. After the vessels are severed and pressure on the ureter is released the pelvis empties readily.

If anomalous vessels are present and one demonstrates to his satisfaction that they are of importance in the production of hydronephrosis, one of several surgical procedures may be necessary. The vessels may first be temporarily occluded to determine their importance in the blood supply of the lower pole of the kidney. If no undue change in color takes place during compression for several minutes the vessels may be severed with impunity. Should the lower pole become very dark and should a sharp line of demarcation appear between the main portion of the kidney and the lower pole, the vessels cannot be divided without producing an infarct in the portion of the kidney which they supply. Under these circumstances, if the vessels are definitely compressing or angulating the ureter, it may be necessary to sever the ureteropelvic juncture and reimplant the ureter into the pelvis on the opposite side of the vessels (4). At times such a pro-

cedure may be indicated when the ureter has been inserted high up on the pelvis and has been compressed against the pelvis by aberrant vessels. At the time of re-implantation the ureter is then placed dependently in the renal pelvis (Fig. 1).

If the pyelectasis found to be associated with anomalous vessels is very extensive and if the pelvic wall is thin and flabby and apparently contains little if any musculature capable of effective peristalsis, resection of the pelvis may be performed (Fig. 2). This procedure has been employed frequently by Walters (9). It is realized that the main object of any operation for hydronephrosis is to improve drainage from the kidney and not primarily to decrease the size of the extrarenal pelvis. If a very large redundant pelvis is present, however, it seems quite possible that urine might stagnate there because of the excessive size of the pelvis and its inability to empty. It has been stated that resection of the pelvis interferes with normal peristalsis (5), however, experience with this type of operation has demonstrated that emptying of the pelvis under certain circumstances may be improved by this procedure. If the pelvis is not too large and if it appears to have active peristalsis, it will usually empty itself satisfactorily after the obstruction has been removed, and resection of the pelvis is not necessary.

*High insertion of ureter into renal pelvis.* One of the common abnormalities found associated with hydronephrosis is high insertion of the ureter into the renal pelvis. Obviously, when this anatomical abnormality exists, dependent drainage of the pelvis is lacking. It may be stated that such a relationship between the pelvis and ureter is merely the result and not the cause of the hydronephrosis and it is difficult actually to prove or disprove this contention. It is true, however, that pyelectasis and varying degrees of caliectasis are not infrequently found to exist when there is no explanation for their occurrence other than the fact that the ureter leaves the pelvis in its middle or upper portion. Undoubtedly, this abnormality can sometimes be rendered more important in its appearance as the size of the pelvis increases. It seems very probable, however, that in certain cases this faulty anatomical relationship is primarily responsible for the production of the hydronephrosis. Frequently, as stasis occurs and as the pelvis gradually enlarges, the upper portion of the ureter is compressed by lateral pressure from the distended pelvis. This results in further interference with drainage. Occasionally fibrous bands hold the ureter closely pressed against the pelvis. Under such circumstances one

is usually surprised that urine leaves the kidney as well as it does. The ureteropelvic juncture may be on the posterior or anterior surface of the pelvis, but it is usually located on the medial aspect of the pelvic wall.

The correction of high insertion of the ureter may be accomplished by a variety of surgical procedures, 3 of which are illustrated in Figures 3, 4 and 5. In general, an operation which does not entirely sever the ureter from the pelvis is to be preferred, when feasible, as the blood supply and nerve supply to the upper portion of the ureter are not disturbed by this type of operation. One of the simplest and most satisfactory procedures consists of simple anastomosis between the ureter and pelvis, so called ureteropyeloneostomy (Fig. 3). In this operation a new opening is made between the most dependent portion of the pelvis and the ureter at the corresponding level.

A second procedure that may be employed, which is quite similar in principle to the one just described, is illustrated in Figure 4 (5). The adjacent portions of the ureter and pelvis are incised in a straight line and the cut edges are then united, posterior edge of pelvis to posterior edge of the ureter and anterior edge to anterior edge, which is similar in principle to the Finney pyloroplasty.

Another procedure which I have not seen described in the literature but which I have employed with satisfactory results in cases of high insertion of the ureter is illustrated in Figure 5. In this operation a longitudinal incision is made in the upper portion of the ureter which lies adjacent to the pelvis. This incision is carried down to a level which corresponds with the most dependent portion of the pelvis, which is near (approximately 1 centimeter) the renal parenchyma of the lower pole. The dependent portion of the pelvis which lies between the lower pole of the kidney and the ureter is then resected in a wedge shaped manner, with the base of the wedge directed downward and the apex reaching upward to the level of, or a little above, the ureteropelvic juncture. The anastomosis between the remaining portion of the pelvis and the longitudinal incision in the ureter is then completed in the usual manner. This procedure has the advantage of bringing the ureteropelvic juncture close to the kidney in a dependent position, creating a funnel shaped pelvis, and furthermore removes the excess portion of the pelvis that usually remains when an ordinary anastomosis is performed without removal of tissue. The operation described by Foley may also be used in cases of this type, although it was described for use in

cases of stricture at the ureteropelvic junction.

Somewhat less conservative operations may at times appear advisable. Occasionally it may seem necessary to sever the ureteropelvic junction completely, resect the upper portion of the ureter which lies adjacent to the pelvis and reimplant the upper end of the ureter in the lowest portion of the pelvis. This may or may not be combined with resection of the pelvis. If the pelvis is resected, the line of incision may be carried to within 1 centimeter of the renal parenchyma both on the anterior and posterior walls. The ureter is then inserted at the lower angle of the pelvis. This procedure, as utilized for stricture of the ureteropelvic junction is illustrated in Figure 6. This type of operation is best reserved for cases of large hydronephrosis in which there is a very thin, markedly dilated pelvis which has flattened and narrowed the upper portion of the ureter. Accurate anastomosis between ureter and pelvis is desirable. The upper end of the ureter may be incised downward for a short distance in order to increase the diameter of the resulting ureteropelvic junction if it appears advisable.

*Narrowing at ureteropelvic junction.* Hydronephrosis may be caused by narrowing of the lumen of the ureteropelvic junction as a result of scar tissue, trauma of one form or another, inflammatory reaction, fibrous bands, idiopathic stricture, or other causes. Many types of surgical procedures have been employed for the correction of this condition with variable results. Employment of the principle of the Heineke-Mikulicz operation for pyloroplasty known as the 'Fenger operation' is one of the simplest procedures technically, however ultimate results following this type of procedure which utilizes a longitudinal incision through the strictured region closed transversely have not been so satisfactory.

Schwytzer modified Fenger's operation by using a Y shaped incision the diverging limbs of the Y being placed on the pelvis above the ureter and the descending limb being extended down the ureter. This incision is closed so that the dependent point of the triangular flap created on the pelvis is approximated to the lower end of the incision in the ureter. The diameter of the ureteropelvic junction is thereby increased with some redundancy in the upper end of the ureter opposite the anastomosis. Foley modified this operation by placing the diverging limbs of the Y incision downward on the lower portion of the pelvis directly opposite the upper end of the ureter. The straight incision in the ureter is made somewhat longer than in the Schwytzer operation and

on the side of the ureter adjacent to the pelvis. The dependent tip of the flap on the pelvis is approximated to the lower end of the incision in the ureter and the anastomosis is completed accordingly. This provides a large ureteropelvic junction with a funnel shaped opening into the pelvis. Satisfactory results have been reported following this procedure.

If the pelvis is unusually large and the upper portion of the ureter somewhat redundant, resection of the renal pelvis and upper portion of the ureter and reimplantation of the ureter usually gives very satisfactory results (Fig. 6). This procedure is especially advantageous when a more conservative operation without resection would leave an excessively large renal pelvis and give doubtful results. In this type of operation it is especially important to leave the ureteral "sphincter" in place for an adequate length of time.

*Square shaped pelvis with medial insertion of ureter.* Occasionally one finds hydronephrosis with a square shaped extrarenal pelvis and a ureteropelvic junction (of adequate lumen) situated dependently on the medial aspect of the pelvis. The ureter is then a considerable distance from the lower pole of the kidney. It is difficult to determine just how an anatomical arrangement of this type might be responsible for the development of the hydronephrosis. It may often appear as though the relationship were merely secondary, the hydronephrosis having developed from some undetermined cause. Whichever the case may be the late results obtained following operation make it appear worth while in some of these cases to resect a wedge shaped portion of the lower part of the pelvis situated between the ureter and lower pole of the kidney. The base of the wedge is excised from the lowermost portion of the pelvis and the apex is directed upward. Such a procedure brings the ureter and ureteropelvic junction close to the lower pole of the kidney and makes the dependent portion of the pelvis more funnel shaped and less flat. Such an arrangement some times appears to enhance drainage.

*Hydronephrosis associated with movable kidney.* That most cases of slightly abnormal renal ptosis or mobility are of clinical significance seems highly improbable and I believe that such a viewpoint will avoid many unnecessary operations. That certain cases of abnormal renal ptosis associated with some degree of hydronephrosis and pain which appears to be of renal origin are of clinical significance seems almost equally certain. I do not think there are many such cases but one is occasionally encountered. If the clinical diagnosis has been established with as much

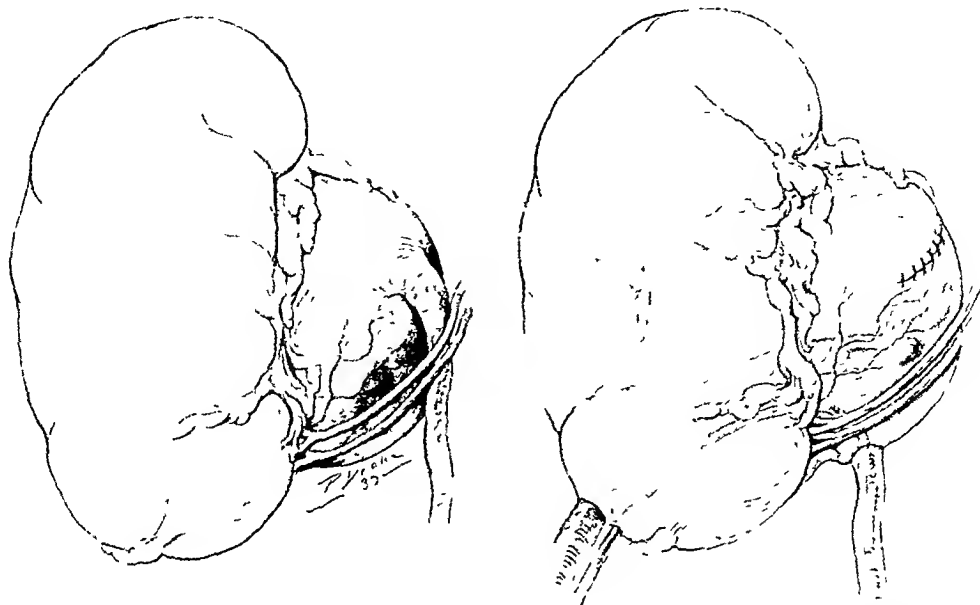


Fig 1 Hydronephrosis associated with aberrant vessels and high insertion of ureter, a, left, high insertion of ureter into the enlarged pelvis, upper portion of ureter compressed by aberrant vessels running to lower pole of kidney, and b, resection of upper portion of ureter and re-implantation into dependent portion of pelvis. The aberrant vessels could not be severed without causing an infarct in lower pole of kidney

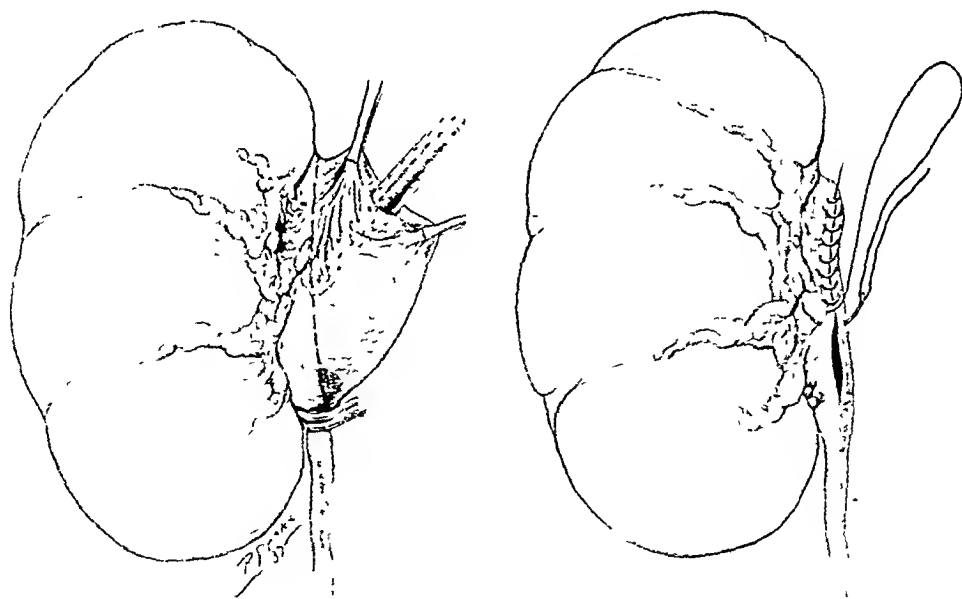


Fig 2 Hydronephrosis associated with aberrant vessels, a, left, compression of ureteropelvic junction by aberrant vessels, and b, aberrant vessels severed and enlarged extrarenal pelvis resected



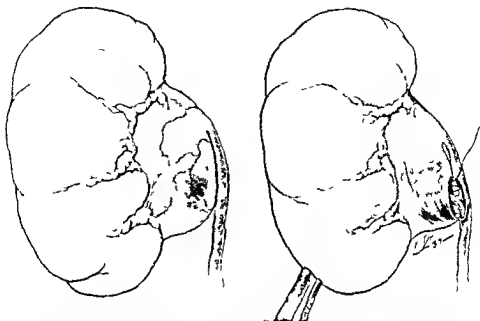


FIG. 3. Hydronephrosis associated with high insertion of ureter. a, left, high insertion of ureter into enlarged pelvis; b, anastomosis between dependent portion of pelvis and adjacent portion of ureter.

certainly as possible and if definite stasis has been actually demonstrated, a pleasing result may follow immobilization of the kidney in an appropriate position so that undue angulation or kinking of the ureter or ureteropelvic junction does not occur. If such a condition is found in the right kidney of a patient who has a low lying liver as is often the case, one need not attempt to maintain the kidney in an anatomically high position where with each inspiration the liver will push down on the upper pole. All that is actually necessary is to fix the kidney in a relatively high position so that it does not descend unduly when the patient is standing. The details of performing nephropexy will not be discussed except to say that elaborate methods of fixation are unnecessary. One does not need to operate on many kidneys which have been subjected to a previous operation before realizing that nature does a very good job of fixing the kidney following almost any type of renal operation.

*Hydronephrosis resulting from other causes.* Hydronephrosis which results from various abnormalities in the lower portion of the urinary tract, and from pathological conditions entirely extrinsic to the urinary tract is not at all uncommon. Tumor of the ureter, ureteral stricture, vesical neoplasm, obstruction in the neck of the

bladder and so forth, and numerous pelvic conditions such as tumors, inflammatory processes and trauma in one form or another may result in obstruction of one or both ureters. Likewise abdominal or retroperitoneal tumors which cause pressure on the ureter or renal pelvis may result in varying degrees of pyelectasis and caliectasis. The treatment of hydronephrosis resulting from these causes will not be discussed since the primary concern under these circumstances is the original lesion responsible for the secondary effects on the kidney. In cases of this type local conservative operation on the kidney is seldom indicated.

*Hydronephrosis of indeterminate origin.* Occasionally one encounters definite hydronephrosis without an adequate anatomical explanation for its development. Sometimes the hydronephrosis may be unilateral at other times bilateral. In children bilateral hydronephrosis without evidence of organic obstruction is not uncommonly seen. It seems possible that disturbances of function may eventually cause an anatomical abnormality for which there is no recognizable organic lesion. Although the exact cause for such hydronephroses to my belief has never been conclusively demonstrated, the current tendency is to explain them on the basis of neuro or neuro-

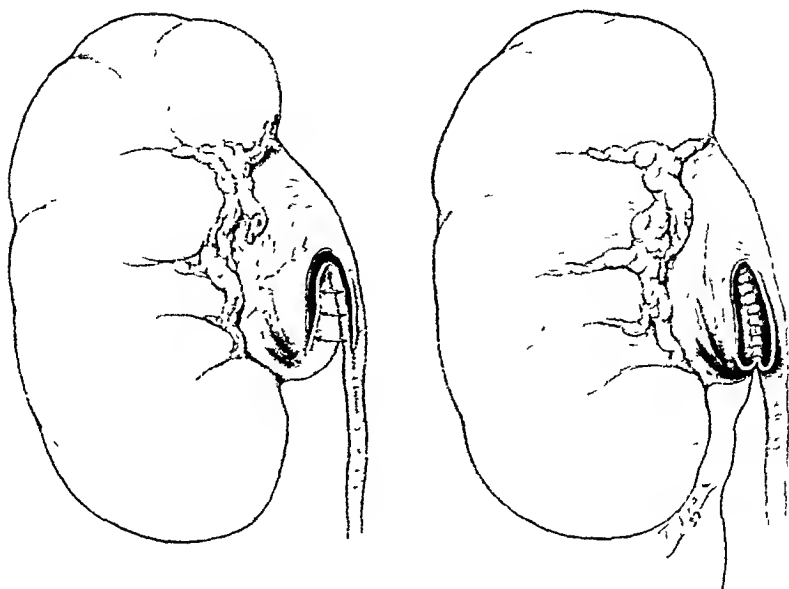


Fig 4 Hydronephrosis associated with high insertion of ureter, a, left, high insertion of ureter into dilated pelvis, b, anastomosis between dependent portion of pelvis and adjacent portion of ureter

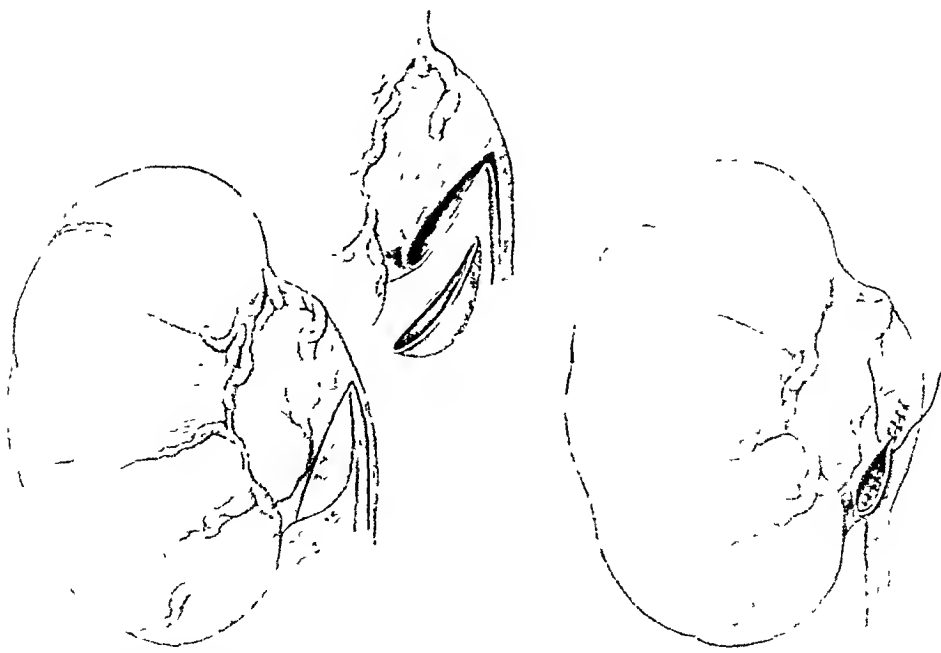


Fig 5 Hydronephrosis associated with high insertion of ureter, a, left, high insertion of ureter into enlarged pelvis, b, wedge shaped resection of lower portion of pelvis and ureteropelvic anastomosis

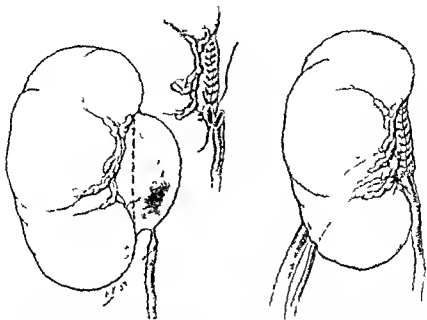


Fig 6 Hydronephrosis associated with structure at ureteropelvic junction a left structure at ureteropelvic junction with resultant hydronephrosis and b resection of extrarenal pelvis and structured region of ureter with re implantation of upper end of ureter into dependent portion of pelvis

muscular dysfunction. Obviously when no actual obstruction is present little benefit may be expected from any type of plastic operation. The ultimate results of various types of operative procedures carried out on the autonomic nervous system in a large series of cases remain to be seen. Individual cases and small groups of cases have been reported with reputed benefit following denervation of the renal pedicle, ureterolysis, section of the ureteropelvic sphincter, and resection of the presacral nerves. Experience has been limited with all of these procedures and they will not be discussed in detail at this time. Suffice it to say that further experience both experimental and clinical, is desirable before definite conclusions can be drawn.

*Hydronephrosis in kidney with duplicated pelvis.* Duplication of the pelvis of one or both kidneys is one of the most frequent congenital abnormalities that occurs in the urinary tract. Often such a condition causes no symptoms as both segments of the kidney function normally and there is no superimposed disease or abnormality. At times however, hydronephrosis or other changes may develop, usually in one but occasionally in both segments of the kidney. When hydronephrosis

develops in one segment only and the other half of the kidney is functioning normally, a conservative operation rather than nephrectomy is desirable.

If hydronephrosis occurs in one segment of a kidney with double pelvis it is usually in the upper half, and it may be caused by a variety of factors such as ectopic lower opening of the ureter or other anatomical abnormality, a kink or sharp angulation in the ureter, narrowing of the ureter by pressure and so forth. For the conservative surgical correction of such a condition a number of different procedures have been utilized with varying degrees of success. Heminephrectomy is the operation which has given the most uniformly satisfactory results at The Mayo Clinic (Fig. 7). In this operation the diseased portion of the kidney and at least a portion of the attached ureter are removed. This procedure is usually not difficult and in a majority of cases can be performed with a low risk and a good result. Complete ureterectomy is not necessary even if marked ureterectasis is present unless there is definite obstruction in the lower portion of the ureter. Ligation of individual blood vessels to the involved portion of the kidney and temporary com-

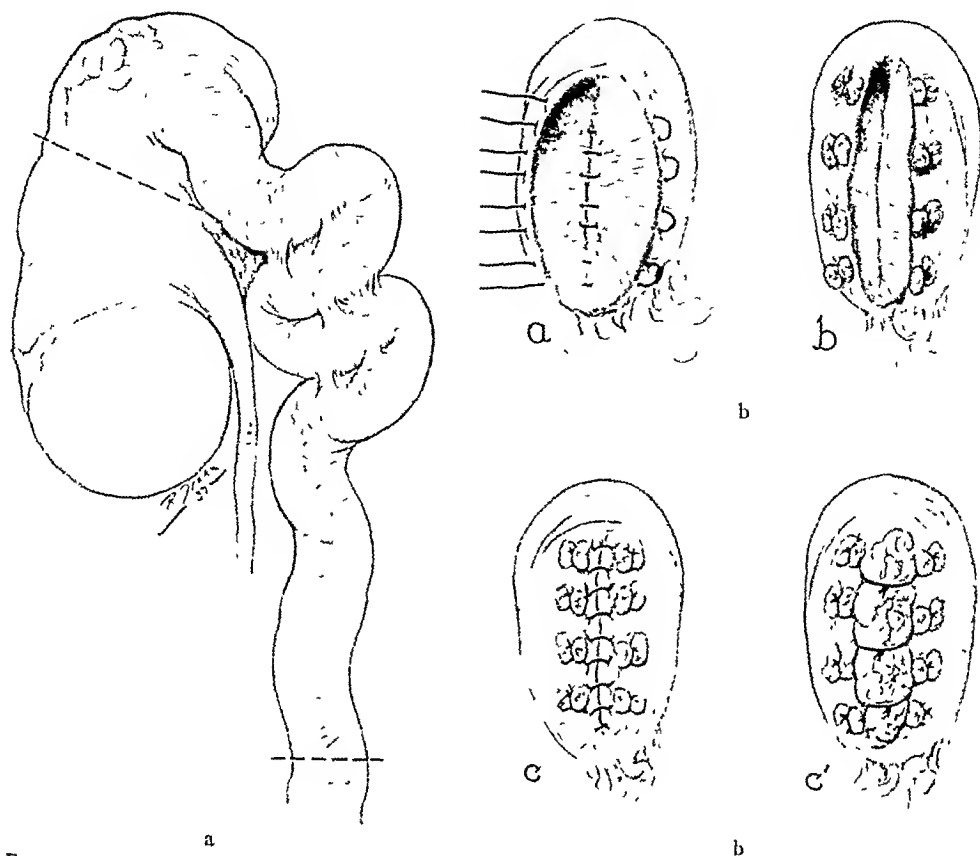


Fig 7 Hydronephrosis in upper segment of duplicated kidney, a, redundant hydro-ureter, the lower half of kidney is normal, and b, heminephrectomy, removing upper half of duplicated kidney

pression of the renal pedicle with a rubber covered clamp facilitate the procedure. The line of resection should be placed so that neither a calyx nor a pelvis is opened. By making a wedge shaped excision of the involved segment, the edges of the defect in the remaining portion of the kidney can be approximated. Large individual vessels seen on the cut surface of the kidney may be ligated with interrupted mattress sutures. Following this the edges of the kidney may be approximated with similar sutures tied over muscle tissue and finally covered with a pad of fat held in place by a continuous running suture through the renal capsule.

Other operations which are described for hydronephrosis in half of a duplicated kidney include mere ligation of the ureter from the involved segment, various types of anastomoses of the ureters and pelvis of the 2 segments, and re-implantation of the involved ureter into the bladder in case it has an ectopic opening. The

enlarged renal pelvis may be anastomosed to the one of normal size. The ureter of the involved segment may be joined to the normal pelvis or ureter. As a general rule, results following these operations are less satisfactory than following heminephrectomy. Occasionally, if it is essential to preserve all possible functioning renal parenchyma, some type of anastomosis or a re-implantation may be advisable.

*Hydronephrosis in a unilateral fused kidney.* Occasionally a unilateral fused kidney presents definite hydronephrosis in one segment with resultant symptoms. Generally this may be treated in the same manner as hydronephrosis in one segment of a duplicated kidney. The exact procedure that is necessary will change with the individual patient, depending on the anatomical and functional relationships encountered.

*Hydronephrosis in an ectopic kidney.* Hydronephrosis sometimes develops in an ectopic kidney. This may be caused by pressure on the

ureter from an abnormal blood supply (which is the rule rather than the exception under such circumstances) or by some other cause of ureteral obstruction such as acute angulation, redundancy with kinking, or external pressure on the ureter. In the surgical treatment of kidneys of this type which are producing symptoms, nephrectomy gives the most uniformly satisfactory results provided the other kidney is in good condition. Because of the abnormal position of the kidney and its unusual blood supply, conservative plastic operations are less often successful than in cases in which the kidney is normally placed. They may at times be necessary, however, because of bilateral renal disease. The exact type of procedure that is indicated will vary from case to case and depends on the cause of obstruction and for this reason no universally applicable procedures can be described. In general, if a conservative operation is performed, the same surgical principles should be utilized as in dealing with a kidney in a normal position.

*Hydronephrosis in a horseshoe kidney.* The horseshoe kidney, which shows evidence of hydronephrosis, usually presents a very clear cut problem at the time it is exposed surgically. It has been our preference at the clinic to utilize the ordinary posterolumbar incision in these cases, continued somewhat more anteriorly than usual, with the patient placed at an angle of 45 degrees with the table. This type of incision and position provide adequate exposure. Obstruction to the free drainage of urine from the pelvis is usually caused by high insertion of the ureter, or pressure on the ureter from aberrant blood vessels, the lower pole of the kidney, or the renal isthmus. Occasionally, angulation of the ureter by fibrous bands may be present.

Depending upon the etiological factors responsible for the hydronephrosis, the surgical indications will vary. Ordinarily plastic operations on the ureter and pelvis can be as easily performed on a horseshoe kidney as on a single kidney. The pelvis is commonly found to lie anteriorly, which compensates for the fact that renal mobility is somewhat limited because of direct attachment to the opposite kidney. In case the hydronephrosis is caused by high insertion of the ureter into the pelvis, ureteroneoepiostomy (Figs. 3 and 4) usually gives a good result. In case the renal isthmus causes pressure on the ureter, which I believe is uncommon, it is necessary to divide the isthmus so that the ureter is not compressed as it passes downward. When this is done it is often essential to fix the lower pole of the kidney laterally to the lumbar muscles in order to avoid

pressure by the lower pole on the ureter. In the limited group of cases of hydronephrosis in horseshoe kidneys in which conservative operations have been performed, the ultimate results have been equally as satisfactory as following operations on single normally placed kidneys.

#### GENERAL CONSIDERATIONS

Certain general surgical considerations that seem important in obtaining satisfactory results following plastic operations on the kidney might be mentioned. Absorbable suture material is universally employed, because nonabsorbable sutures may readily form the nidus for crystalline deposit, especially when infection is present. Personally, I prefer a single row of interrupted catgut sutures for closing the pelvis. There may be some slight leakage of urine during the early postoperative period with this type of closure, but this does no real harm and affords an additional safety valve in case of increased intrapelvic pressure. Additional rows of suture are unnecessary and only increase the amount of local reaction and tissue that subsequently will slough.

Drainage by nephrostomy is widely recognized as a valuable adjunct to practically every plastic operation performed on the ureteropelvic juncture. With such provision for immediate drainage during the early postoperative period, the incidence of secondary nephrectomy and functional failure of operation is definitely reduced.

When any procedure has been carried out at the ureteropelvic juncture, the use of an indwelling catheter which traverses the lower pole of the kidney, lower calyx, pelvis, ureteropelvic juncture, and ureter in order so called "ureteronephrostomy" is of definite value. A small, soft rubber catheter size 10 to 14 French is preferred to the commonly employed harder, smaller ureteral catheter. An extra hole is cut in the portion of the catheter that remains in the pelvis so that there may be free drainage of urine through the catheter either outward to the collecting bottle or downward to the bladder. The catheter should be passed down the ureter a sufficient distance so that it will not be easily dislodged. This catheter serves to maintain an adequate lumen of the ureter at the site of operation and in addition discourages undesirable angulation of the ureter which might otherwise occur during the early postoperative period. The length of time that the catheter and nephrostomy tube are left in place varies with the individual case. If an extensive plastic operation has been performed, such as complete resection of the renal pelvis and reimplantation of the ureter, it may

be advisable to leave the tube in place for as long as 3 months. If a less extensive type of procedure has been carried out, 3 weeks may be ample. In general it is wiser to err on the side of leaving the tubes in place for too long rather than too short a time. As healing occurs and as the resultant scar tissue contracts, the lumen of the ureteropelvic juncture may be narrowed unless the catheter remains in place.

It is generally advisable to fix the kidney in a position which is most favorable to good drainage at the conclusion of a plastic operation. This does not mean that the kidney must always be fixed in exactly the same position nor in the same manner. The most desirable position must be ascertained in each individual case and the kidney then immobilized in this position. The wound should always be drained.

#### COMMENT

As one can readily surmise from a brief review of the many different surgical procedures that have been suggested and tried in the conservative treatment of hydronephrosis, the surgical management of this condition is far from standardized. Although it is more than 50 years since the first plastic operation on the kidney was reported (8), relatively few operations of this type were performed until 20 years ago. Since then this field of surgery has expanded greatly and, at present, many plastic operations are performed on the kidney each year. Some of the earlier procedures have been discarded and certain newer ones have been developed. As more time elapses,

evaluation of ultimate results will become more accurate. At some time in the future the technical aspects of conservative renal surgery will undoubtedly become more standardized, and perhaps certain of the procedures which are utilized today will be altered or discarded.

#### REFERENCES

- 1 BOOGARD. Quoted by Mathé, C. P. The rôle of aberrant vessels in the production of hydronephrosis. *J Urol*, 1928, 19, 211-240.
- 2 FLINGER, CHRISTIAN. Operation for the relief of valve-formation and stricture of the ureter in hydronephrosis or pyonephrosis. In *The collected works of Christian Fenger* Vol 2, pp 687-704. Philadelphia W. B. Saunders Co., 1912.
- 3 FOLEY, F. C. B. A new plastic operation for stricture at the ureteropelvic junction. *J Urol*, 1937, 38, 643-672.
- 4 KUESTER. Ein Fall von Resection des Ureter. *Arch f klin Chir*, 1892, 44, 850-854.
- 5 VON LICHTENBERG, ALEXANDER. Plastic surgery of the renal pelvis and ureter. *J Am M Ass*, 1929, 93, 1706-1708.
- 6 MAYO, W. J., BRAASCH, W. F., and MACCARTY, W. C. Relation of anomalous renal blood vessels to hydronephrosis. *J Am M Ass*, 1900, 52, 1383-1388.
- 7 SCHWYZER, ARNOLD. A new pyelo-ureteral plastic for hydronephrosis. *Surg Clin N America*, 1923, 3, 1441-1448.
- 8 TRENDLENBURG. Quoted by Schwyzer, loc cit.
- 9 WALTERS, WALTERMAN. The conservative treatment of hydronephrosis by resections of the renal pelvis and other plastic operations. *J Urol*, 1933, 29, 121-134.
- 10 WALTERS, WALTERMAN, CABOT, HUGH, and PRIESTLEY, J. T. Operative results in noncalculus hydronephrosis. *J Urol*, 1937, 38, 688-701.
- 11 WINSBURY-WHITE, H. P. Observations on hydronephrosis with special reference to aberrant vessels. *Tr Am Ass Genito-Urin Surg*, 1936, 29, 381-401.

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### "DECOMPRESSION" OF THE INTESTINAL TRACT

ACCORDING to Paine, the first stomach tube was probably made and used by John Hunter in the latter part of the eighteenth century. Shortly thereafter improvements in the types of tubes were reported in the United States, France and England. Kussmaul rediscovered the stomach tube in 1863 and it is due in no small part to him that it was popularized as a diagnostic and therapeutic instrument. Ewald and Oser in 1874 described stomach tubes made of soft rubber and with a smaller lumen and showed that they could be introduced without using styles.

Most of the pioneer work on the development of the duodenal tube was performed in America. Turck and Hemmeter described tubes with which the duodenum had been intubated. Shortly thereafter Finhorn and Gross independently simplified and improved them. Gross recommended that the patient should lie on the right side after the tube had been

swallowed in order to facilitate passage into the duodenum. Levin in 1921 described the smooth catheter tipped duodenal tube which could be passed through the nares. Many other types have been described but extensions in the indications for usage have greatly outstripped the improvements in construction.

Whereas the duodenal tube was employed almost exclusively as a diagnostic procedure for many years, it is being used more and more in recent times as a therapeutic agent and particularly in the treatment of intestinal distention. Approximately 25 years ago, its use for continuous siphonage drainage was advocated by Westermann and Karpis in the treatment of distention associated with peritonitis. Kanavel and Matas made contributions to this subject. The work of McIver and his associates in which they showed the important role played by swallowed air in the genesis of postoperative distention has extended the indications for decompression therapy. Many surgeons have treated postoperative distention and other conditions by the use of the duodenal tube as a siphon. Ward of San Francisco was the first to employ continuous suction to the duodenal tube in the treatment of peritonitis. Wangensteen was the first to use the principle of continuous suction applied to the duodenal tube in the treatment of some types of mechanical obstruction of the small intestinal tract. The popularization and perfection of this therapeutic procedure is due largely to Wangensteen and Paine. Whereas siphonage is efficient in the drainage of the urinary bladder and other closed cavities of the body, they showed that the difference in the effectiveness of siphonage drainage of the gastro intestinal tract as contrasted with the

other cavities is dependent on the presence of gas as well as fluid which enters the tube and stops its action. Siphonage is dependent on the difference in the heights of two columns of water and the presence of a moderate quantity of gas destroys its effectiveness. Continuous mild suction is a better means of removing the combination of gas and fluid. Wangenstein and Paine have shown that, when the obstruction is due to adhesions and is accentuated by the accompanying distention, it may be relieved permanently by suction applied to a duodenal tube. Further, they showed that deflation of the stomach and upper part of the small intestines renders the operation, if such is necessary, less dangerous and easier to perform. In this connection, it may not be amiss to state in a short-circuiting operation in which collapsed and distended loops of intestine are anastomosed that one should be certain that the collapsed intestine is not that which has been decompressed by the tube and hence is proximal to the point of obstruction.

However, there are a good many patients in whom gastroduodenal suction is not successful in relieving the distention. Furthermore, even though the distention is relieved by the duodenal suction, the location and nature of the lesion may still be unknown. It is in these cases that the intestinal intubation method of Miller and Abbott may achieve gratifying results. In principle, the method consists of passing through the nose into the small intestinal tract a double lumen tube or a pair of tubes, the larger opening being used for aspiration purposes and the smaller one for the inflation of a rubber balloon which surrounds its distal end. With the combination of aspiration of the intestinal contents and of inflation of the balloon, peristalsis carries the tube down the intestinal tract. This takes place whether the obstruction is mechanical or paralytic. It offers an interesting and new method for

many physiopathological studies on man and animals. Striking results following its use in patients with distention due to several causes have been reported by Abbott and Johnston, Penberthy, Noer and Kenning, and by others. In a number of instances, decompression has released the obstruction and operation has been unnecessary. The tube usually advances until the tip reaches the point of obstruction. Under these conditions, examination of the aspirated material and the injection of an opaque suspension combined with x-ray studies may reveal the location and the nature of the lesion.

The men who have developed the methods for decompression of the intestinal tract are quite conservative in their claims. It is emphasized that this therapy should not be used in cases of strangulation of any part of the intestinal tract and in instances of obstruction of the large bowel. Since strangulated external hernias usually present no difficulty in diagnosis, costly mistakes are most apt to occur in instances of volvulus, internal hernia, and intussusception. Since early operation is urgently indicated in patients with strangulation, the time required for the passage of the tube is not permissible. The greatest difficulty usually lies in getting the tube to pass through the pylorus into the duodenum but it is likely that better methods for doing this will be evolved. In general it may be stated that a trial with suction is permissible in those cases in which clear indications for immediate operation do not exist. It cannot be emphasized too strongly that the person who elects to treat a patient with mechanical obstruction by non-operative means must use the x-ray in following the results of the therapy. If suction does not result in decompression in 24 to 36 hours, an operation is indicated. Prolonged non-operative management is apt to be especially dangerous in the absence of a



history of previous abdominal operations since under these conditions adhesions are not so likely to be the cause of the obstruction.

If the contra indications to the use of intestinal intubation are understood fully and, if the patients are chosen properly, the method may offer many advantages. It may make an operation unnecessary by relieving the distention above the point of obstruction with a resulting re establishment of the normal intestinal continuity. Even if an operation is necessary, it may be used in preparing the patient by relieving the distention, making for an easier procedure both for the patient and the surgeon. It offers a non operative means of combating the distention in paralytic ileus. Conditions other than mechanical obstructions in which the employment of suction may be indicated include the physiological obstructions whether they accompany operations, infection, or a variety of conditions including the distention accompanying uremia, pneumonia, and fractures. The work of Fine, Sears, and Banks indicates that the inhalation of oxygen may be effective in combating the distention associated with some of these conditions. Intestinal intubation offers a means of supplying fluids when they are needed urgently. It affords a possible method for determining the location and nature of the lesion in the intestinal tract. It may be used to diminish the tension on sutures in the intestinal tract or to permit a greater delay in the making of an opening in an exteriorized portion of the intestines. Following eviscerations through incisions, it may be employed in combating distention. Duodenal suction alone will be effective in many of these conditions but the use of the double tube with the balloon increases the area which is accessible.

The therapeutic procedures enumerated are relatively new and undoubtedly many improvements in the methods now used will be

made. Since they offer such bright possibilities, it is hoped that indiscriminate and ill advised usage will not retard their development. It seems quite likely that the decreasing popularity of enterostomy in the treatment of ileus, paralytic and otherwise, will decrease still further as a result of the effectiveness of these non operative means of therapy.

ALFRED BLALOCK

## HYDATIDIFORM MOLE AND CHORIO-EPITHELIOMA

A STUDY of the extensive papers on hydatidiform mole and chorio epithelioma written prior to 1930 (the year in which the Aschheim Zondek test became of practical use) reveals that the mortality rate for mole was approximately 12 per cent and that of chorio epithelioma 60 per cent. During that period hydatidiform mole was usually not diagnosed until hydatid vesicles were demonstrated, and the presence of chorio epithelioma was not suspected until metastases had appeared. A recent five year survey of these two diseases on the Pacific coast and a review of the world's literature for 1935, 1936 and 1937 shows that the mortality rate for hydatidiform mole and for chorio epithelioma has dropped to 2 per cent and 10 per cent, respectively. Analysis of the recent literature points to the fact that the decreased mortality is the result of early diagnosis by means of the various biological pregnancy tests which have come into vogue and early treatment by hysterectomy.

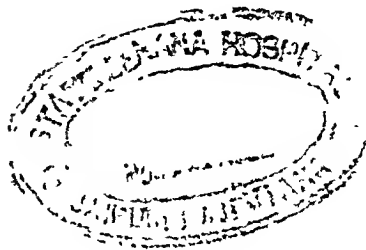
At the present time there is sufficient evidence in the literature to show that it is wise to leave the ovaries when hysterectomy is performed. The exceptions to this rule would be, of course, primary chorio-epithelioma of the ovary following ovarian pregnancy, pri-

mary chorio-epithelioma of the ovary due to a chorio-epitheliomatous growth in a teratoma, or actual metastases which seriously involve the ovary. Torsion of an ovary containing lutein cysts or enormous enlargement of an ovary as a result of lutein cysts would probably necessitate removal of the involved ovary.

In order that even better results may be obtained, loose concepts must be abolished, more exact knowledge and better interpretation of the tests for gonadotropic hormone must be had, and a technique better than is at present extant is needed so that the most minute amounts of living chorionic tissue can be detected. And it is to be hoped that pathologists by more extensive and more painstaking

examination of the mole will ultimately be able to formulate criteria that will establish potential malignancy and thus enable us to prophesy the advent or to determine the existence of chorio-epithelioma. The highest percentage of cures will be obtained when there is judicious correlation of the clinical history, verification of the histological examination, and intelligent interpretation of the biological pregnancy tests. It would appear if modern criteria are used, early diagnosis made, and early operative treatment instituted that the woman with chorio-epithelioma will have approximately a 95 per cent chance to get well and keep her ovaries.

ALBERT MATHIEU



# THE SURGEON'S LIBRARY

## REVIEWS OF NEW BOOKS

THE first edition of Cowdry's book on histology departed radically from the traditional type of student text. In the opinion of the reviewer it blazed a new trail in demonstrating the possibilities of histological presentation on a correlated functional basis. But by the very nature of the case such treatment has its practical handicaps. If it combines morphological description with functional exposition then one or both must suffer unless the book attains undue size. This has been Professor Cowdry's problem from the outset and he has met it courageously and without wavering from several unorthodox pedagogical convictions. He believes that most text books waste space with the obvious, that preliminary instruction on the cell and fundamental tissues is unsound and unnecessary, that a histological text should be built around the blood vascular system as the great integrator. These citations alone will illustrate how unusual is the plan and content of his book.

In the present edition some concessions have been made to friendly criticisms. A historical and orienting introduction now is included. Many figures have been added to illustrate normal variations upon which depend degrees of physiological activity. More attention has been given to bridging the gap between gross and microscopic anatomy and the abundant inclusion of contemporary research has been extended and controversial subjects aired.

It would seem that this book will still be difficult for the tyro who arrives at medical school and must plunge forthwith into the curricular maelstrom. Probably most teachers doubt their students' capacity to assimilate such strong diet. Just possibly it is the teachers who are at fault by being overtimorous. But the hours available to histology are so few that it would seem the wisest course to many to use them in instilling first the tried fundamentals and then presenting as much of contemporary trends and physiological interpretations as may be possible. Yet no serious medical student should be without access to this stimulating and informative book. From it he will gain an insight into science in the making, learn to do correlative thinking and be disillusioned as to the existence of dogmatism even in what at first might seem a stabilized subject. As a companion reference the book is ideal. It is difficult to restrain one's enthusiasm in recommending Professor Cowdry's text to the alert clinical practitioner. If his histology dates back more than ten years he will be astonished at the meagerness of his concepts

of modern histology as made to live through the pen of one of America's acknowledged master histologists.

I B A

THIRTEEN successive editions of Osler's *Principles and Practice of Medicine* have faithfully recorded progress over a period of 46 years, the most fruitful in the history of medicine. Eight editions were prepared by Osler himself and four by McCrae. Now Christian, a pupil of Osler and a friend and colleague of McCrae, carries on the tradition. The original work in 1862 met with such success that it immediately superseded all other textbooks of general medicine. Cushing in his classical biography of Osler wrote that the volume was "what might be called a practical pathology in which were given the results of modern investigation, microscopical, bacteriological and chemical." On their foundation was built up the symptomatology and diagnosis of disease and where a specific form of treatment was known to avail it was given its due prominence. Otherwise there were few recommendations beyond giving a chance to Nature aided by proper nursing and hygiene. Credited as indirect results of this work and its author's honest skepticism concerning drugs are the establishment of the Rockefeller Hospital and the interest in the prevention and cure of disease shown by the General Education Board. The influence on medical students has been incalculable.

Christian's revision is an admirable achievement. It continues successfully the traditions of his predecessors, attuning them to such newer knowledge in the field as has developed by means of rearrangement, rewriting and the addition of new material. The book remains exceptionally readable, authoritative and concise and will continue to hold the field. The new edition contains 1,424 pages as compared with 1,070 in the original. In the opinion of this reviewer the Osler-Christian book still enables the medical student better than does any other text to effect a transition from pre-clinical subjects to clinical medicine. The practitioner will find it readable, compact and authoritative, conservative and adequate but not usually detailed as regards treatment. Of volumes by one author it has in the opinion of the reviewer no peer although texts containing articles by many different authors are available that may be more informative to the practitioner.

WALTER H. NADLER

A TEXTBOOK OF HISTOLOGY. By F. J. Cowdry. 1935. Philadelphia: Lea & Febiger. 1935.

THE PRINCIPLES AND PRACTICE OF MEDICINE. Edited for the 13th Edition by Osler and McCrae. Originally written by the 13th Edition. Edited by Christian. 1935. Philadelphia: Lea & Febiger. 1935.

THE fourth edition of Boyd's *Surgical Pathology*<sup>1</sup> exhibits no departure from the highly satisfactory method of presentation found in the preceding editions. The treatise is divided into thirty-seven chapters which are carefully selected, and comprise practically all of the more commonly encountered diseases in the realm of surgery. An interesting introductory chapter on surgery and pathology, omitted for the first time from the third edition, has been reinserted. Included among the new subjects are lymphogranuloma inguinale, primary thrombosis of the axillary vein, glomus tumor, pilonidal cyst, Hashimoto's disease, parathyroid tumor, regional ileitis, the pathology of the intervertebral discs, Gradenigo's syndrome, and tumors of the islets of Langerhans.

The rewriting of the chapter on diseases of the rectum has vastly improved the section on ulcers and fistulas. The pathogenesis of these conditions is discussed in a manner quite commensurate with the contemporary understanding of the subject. In the chapter on appendicitis, considerable attention is paid to the work of Wangenstein and Bowers demonstrating that obstruction plays an all important rôle in appendicitis. The author declares that in recent years much progress has been made in the study of neoplasia. He points out the significance of the phenathrene ring in the experimental production of cancer. New material is also included on the relation of the hypothalamus to gastric ulcer, the pathogenesis of renal calculi, and the relation of chronic mastitis to carcinoma of the breast.

No effort is made to have the experimental work on any subject complete. The author, instead, carefully selects what, in his opinion, is significant. By this method the material is brought quite well up to date, and the size of the book is prevented from becoming unreasonable. The text reads easily and is very fresh and alive, due most probably, to the discussions on pathologic physiology. This is correlated with the gross and microscopic pathology and the symptomatology in such a way as to make an extremely elucidating and interesting work. The author's style is direct and concise and possesses unusually good literary form for a medical book. The volume should certainly be in the library of every surgeon and pathologist.

ALEXANDER SLIVE

EVERYONE who has used carbon dioxide and oxygen for therapeutic purposes should read Henderson's *Adventures in Respiration*<sup>2</sup>. Why? Because the book is written by the discoverer of the therapeutic use of carbon dioxide and oxygen in such a clear and interesting manner that every physician and medical student can comprehend and enjoy reading the facts regarding the acapnia theory, the theory upon which the therapy is based. It is only

with such information in mind that the therapy can be most rationally used. The author's method of "resuscitation from asphyxia" has undoubtedly saved many lives. The facts upon which this accomplishment is based are presented truly as the author states, "as a simple story of adventures adventures in respiration as I have myself experienced and enjoyed them."

A C IVY

PROCEDURES for practically all situations in plastic surgery are included by Barsky in his recent book<sup>3</sup> and, according to the preface, these procedures have been evaluated and have been successful in his hands and the hands of his colleagues. The usual diagrams of methods of closure of small defects are outlined along with type of anesthesia used. The section on free skin grafts lacks photographs of results obtained which would make the text inadequate were it not for the fact that further details of grafting appear under other chapter headings. One is especially surprised in examining the diagram showing the thickness of various grafts to find that the same mistake has been made as in other texts; for example, a split or thick Thiersch graft is shown being cut through the basal layer of the epidermis. The author states in the text, however, that the split graft is cut one-half to three-fourths the thickness of the skin. Apparently he has not correlated this statement with the mistaken idea shown in the illustration.

An upper lip mucous membrane flap is recommended for a small vermilion loss on the lower lip but no mention is made of the method employed by New and others, simply to mobilize the mucous membrane on the inside of the same lip and advance it. In the chapter on jaws, the subcutaneous section of the ramus for retrusion is credited to Padgett instead of to Blair.

Nose operations are quite fully described and there is a wealth of material in the book, but one might surmise that the subject of plastic surgery needs a larger text if the entire field is to be covered. The book should receive a good reception by the increasing demands of surgeons who find it difficult to obtain the scattered articles in the literature that describe the procedures now in general use.

JAMES BARRETT BROWN

THE authors—professor and associate professor, respectively, of pathology in Temple University School of Medicine—of *Essentials of Pathology*<sup>4</sup> present what they consider fundamental and essential in pathology by a new method. In general outline, the familiar and orthodox division into general pathology, tumors, and systematic or special pathology is followed. But within the several chapters "a concise discussion" of each specific pathological condition or disease is followed by one or more "carefully

<sup>1</sup>SURGICAL PATHOLOGY. By William Boyd, M.D., LI.D., M.R.C.P. (Ld.), F.R.C.P. (Lond.), Dipl. Psych., F.R.C.S. 4th rev. ed. Philadelphia and London: W. B. Saunders Co., 1938.

<sup>2</sup>ADVENTURES IN RESPIRATION. Modes of Asphyxiation and Methods of Resuscitation. By Yandell Henderson. Baltimore: Williams and Wilkins Co., 1935.

<sup>3</sup>PLASTIC SURGERY. By Arthur Joseph Barsky, M.D., D.D.S. Philadelphia and London: W. B. Saunders Co., 1938.

<sup>4</sup>ESSENTIALS OF PATHOLOGY. By Lawrence W. Smith, M.D., and Edwin S. Gault, M.D. With a foreword by James Ewing, M.D. New York and London: D. Appleton-Century Company, Inc., 1938.



# SURGERY

## GYNECOLOGY AND OBSTETRICS

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### EXPERIENCES WITH EMPLOYMENT OF SUCTION IN THE TREATMENT OF ACUTE INTESTINAL OBSTRUCTION

A Reiteration of the Indications, Contra-Indications, and Limitations  
of the Method

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**S**EVEN years ago, one of the authors reported the successful decompression of 3 instances of acute mechanical intestinal obstruction by continuous suction applied to an indwelling tube (18). It was then indicated that the chief rôle of conservative decompression in the management of mechanical obstruction of the bowel would probably be found to be in instances of adhesive obstruction in which drainage of the bowel would permit automatic re-establishment of luminal continuity. It was asserted then also that colonic obstruction accompanied by great distention and strangulating obstructions were absolute contra-indications to attempts at achieving release of the obstruction by suction. In the intervening years, a number of expressions have come from this clinic upon the management of bowel obstruction (19, 20, 21, 22, 23, 24). Save for an analysis of the experience gained dur-

ing the first 2 years (25), no systematic study of the rôle and the successes and failures of the suction management of acute mechanical obstruction of the intestine has been made since in this clinic. The invitation to review the experience of this clinic with the method is, therefore, not only welcomed but recognized as a duteous obligation.

As explained in the initial communication, the idea that the small bowel when obstructed could be decompressed by an indwelling duodenal tube was no accidental observation but the outgrowth of quantitative determinations of the gas and fluid escape through enterostomy tubes following operative relief of obstruction. As soon as drainage of the bowel proximal to the obstruction permits re-establishment of intestinal continuity, the escape of gas and fluid through the enterostomy usually ceases.

The indications and the contra-indications for the employment of suction applied to an indwelling duodenal tube in the management of acute obstruction have remained essentially the same during these 7 years. These have

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This study was supported by a grant from the graduate school. Presented at the meeting of the Western Surgical Association, Omaha, Nebraska, December 1938.

been described so often that they will not be repeated here. The relative indications for the employment of suction are so many that it would be well to reiterate a warning which has been uttered on other occasions, namely, "The practice of employing suction as a test procedure to indicate whether operation will be necessary leads only to deferment of appropriate treatment." Neglect of this admonition is the most mischievous error into which one may fall in the application of suction to patients with intestinal obstruction.

It is to be admitted freely that suction in such instances is a "blind method" far more dim sighted than "blind enterostomy," in the use of which method, at any rate, the abdomen is opened. It is highly important, therefore, that he who uses the method be acquainted not only with its shortcomings, but also with the intricacies and limitations of diagnosis of acute abdominal disorders. Bearing in mind the significance of *intestinal colic*, the absence or presence of demonstrable peritoneal tenderness, the character of the gastric aspirations and the disclosures of the scout film of the abdomen, the trained clinical observer can tell usually with high accuracy (1) whether obstruction is present, (2) whether the obstruction is simple or strangulating in character, (3) where the obstruction is and (4) whether it is complete or incomplete. Often he cannot say what the causative agency is or just how the bowel is obstructed. Determination of the exact pathological mechanism of the obstruction without operation is, therefore, almost invariably conjectural. Yet except for rare occurrences of enteric intussusception or obstruction by gall stones, deductions made from a summation of the clinical and roentgenographic evidence in instances of simple obstruction are ordinarily accurate. He who elects to employ suction in the presence of *intestinal colic* accompanied by rebound tenderness of the abdominal wall does it at the great risk of treating a patient conservatively who has a strangulating type of obstruction. The only source of error is that such a patient may have a simple mechanical obstruction as a consequence of an inflammatory lesion which provokes tenderness. This differentiation unfortunately can

not be made always. It is no idle academic discussion, for many an inflammatory lesion is extended by invading the peritoneal cavity unnecessarily. At the same time, it is foolhardy and dangerous to treat conservatively a patient who may have a strangulating type of obstruction.

Furthermore, patients with strangulated gut, who are observed only after the elapse of some time, may be incorrectly identified as instances of peritonitis of inflammatory origin. Untrained observers particularly are likely to fall into this error. With the escape of fluid into the peritoneal cavity, the *intestinal colic* becomes less and less a prominent feature and may be elicited with the stethoscope only after long periods of waiting and listening at the bedside. Yet, observant attention to the story and the lending of a careful and attentive ear for the presence of abdominal sounds and noises over protracted periods of time, should serve to eliminate this potential source for tragic blunder. It is an error which hedges about the recognition of the presence of bowel obstruction rather than over choice of treatment.

The trained observer is more likely to err in overextending the relative indications for suction than he is in misapplying suction to a patient with a strangulated gut in whom exploration is mandatory. Untrained observers may fail to identify strangulating obstructions and confuse them with primary inflammatory lesions. Such has been the experience in this clinic.

#### EVALUATION OF RESULTS

The strength and weakness of a therapeutic measure can be appraised only by extensive trial and a study of the results. The scheme employed in the report (25) of 1933 will be followed in the evaluation of the suction method. That study included a few patients seen in consultation in other hospitals in the metropolitan area of the Twin Cities. This study relates only to patients admitted to the University Hospital in the 7 year interval between June 1, 1931 and June 1, 1938. In the earlier study all patients were seen by 2 observers (Faine and Wangenstein). This study parallels more closely common hospital

practice in which the responsibility for observing and treating the patient is shared by a much larger group of men. While the senior author of this paper has been responsible for outlining the general policy of management and a large number of the patients have come under his immediate attention, somewhat more than a dozen staff members and surgical residents have shared the responsibility of determining the choice of a therapeutic procedure in the series of cases reported herewith and of performing the necessary operations.

#### DIVISION OF CASES

The tabulated results include all patients with acute mechanical obstruction of the small intestine that have been observed at the University Hospital in the interval between June 1, 1931, and June 1, 1938. To be certain, suction applied to an inlying duodenal tube has played no significant function as a sole agent in such cases as strangulated hernias and intussusception. Yet, it has appeared important to consider all patients with obstruction of the small intestine in this study to indicate more accurately what the rôle of suction is considered to be. Patients with obstruction of the colon have been excluded from this study for, as has already been stated, conservative decompression concerns essentially obstruction of the small intestine. Only those patients with colonic obstruction in whom distention is not a prominent feature are suitable for attempts at decompression by an inlying duodenal tube. In all patients in whom great distention of the colon exists, immediate operative decompression is indicated. It should probably be said, however, that 6 patients with acute colonic obstruction in whom the distention was only of moderate grade have in this interval of time been treated by an inlying duodenal tube and suction, thereby avoiding colostomy as an initial operative procedure. There were no deaths in this group. The experience of any clinic in the management of acute bowel obstruction cannot be sampled adequately unless all types of cases are recorded. Even though the employment of suction does not relate significantly to the treatment of patients with acute obstruction of the large bowel save as a

secondary auxiliary factor, the experience of this clinic in the management of such cases also will be detailed briefly. Patients with inflammatory intraperitoneal lesions in whom distention occurred and other types of physiological ileus, in the relief of which suction is an important therapeutic agency, are not considered in this study save in those few instances in which the presence of mechanical obstruction to intestinal continuity was affirmed on good factual data.

The cases have been grouped as follows

##### 1. *The suction group*

A. Patients in whom suction applied to an inlying duodenal tube was the only treatment directed at the relief of the obstruction (no operation).

B. Patients decompressed by suction but operated upon subsequently because of demonstrated or conjectured persistence of obstructive mechanism.

C. Patients in whom suction was unsuccessful in effecting decompression and in whom operation became necessary for satisfactory relief from acute obstruction.

##### 2. *Patients treated by immediate operation*

A. Intraperitoneal obstructions.

B. Strangulated hernias

C. Intussusceptions

3. *A miscellaneous group in which no therapy directed at the relief of obstruction was carried out because the patient was*

A. Moribund or dead on arrival at the ward.

B. The obstruction had righted itself spontaneously

C. The presence of obstruction was not recognized

#### RESULTS

The results are to be noted in the tables for each group. A brief synopsis is to be found in Table VIII. The salient information regarding all patients who died is tabulated briefly. The case records of fatal cases are, in the main, far more deserving of study and at the same time more instructive than are the successes.

In the calculation of mortality a "corrected factor" has been introduced to denote those patients who died of intestinal obstruction. In a series such as this a number of patients are observed with terminal carcinomatosis or extraperitoneal infection in whom acute mechanical obstruction occurs as an incident. If the management of the distention failed to relieve the obstruction, the death is counted as being due to obstruction; if on the con-



TABLE I—GROUP 1—THE SUCTION GROUP

A Patients in whom suction applied to an intying duodenal tube was the only treatment directed at the relief of the obstruction—no operation

	Patients	Cases	Deaths	Per cent mortality		Late deaths	Corrected mortality per cent	
				Patient	Case		Patient	Ca
Obstruction complete	37	66	20	54%	30%	6	7	6
Obstruction incomplete			4					
Seen twice in Group A	4							
Seen 3 times in Group A	1							
Seen in other groups	6							
Seen previously in Group 1B	3							
Seen subsequently in Group 1B	1							
Seen previously in Group 1C	1							
Seen subsequently in Group 1C	5							
Classified also in Group 2 (death No. 10)			1					

## Deaths in Group 1

The first 6 deaths are considered as unrelated to the obstruction

1 E.D. No. 624561 female aged 74. Patient had generalized carcinomatosis primary in the ovary and partial intestinal obstruction. Relief was secured by suction applied to an intying duodenal tube but patient could not tolerate clamping of the tube. Patient died 31 days after admission.

2 F.E. No. 62397 male aged 50. Patient had a perforated peptic ulcer repaired 11 months previously. He came in for treatment of bilateral emphysema and lung abscesses. During the hospital stay patient developed small and large bowel obstruction controlled by suction. The patient died of toxemia due to abscesses and emphysema and of respiratory embarrassment. Autopsy also showed adhesive bands.

3 O.H. female aged 18. Patient had an 11-day history of symptoms of small bowel obstruction on an adhesive basis. Suction gave partial relief in 24 hours and complete decompression in 48 hours. Duodenal tube was removed in 144 hours. The patient was symptom free for 3 days and then died suddenly. The mode of death strongly suggested suicide by poisoning. However this was not proved.

4 C.S. No. 662467 male aged 62. History was unreliable. Patient had had chills, sweats, cough, obstipation, considerable vomiting and increasing abdominal distention for 6 or 7 days. Mass was palpable in the left lower quadrant. X-ray findings after an ambrothor meal were interpreted as obstruction in the upper small bowel probably due to carcinoma. The patient refused surgery despite frequent urging and was treated with moderate relief by suction. The patient expired on the fourteenth hospital day. 11 days after surgery was advised. Autopsy was refused.

5 O.M. No. 66054 male aged 61. This patient had had resection of carcinoma of the sigmoid colon done elsewhere 2 years before admission. At the time of admission he had had quite severe back pain for 4 months and had lost 20 pounds during this period. On the fourth hospital day the patient developed partial intestinal obstruction and was treated by means of duodenal suction for 11 days. The obstruction seemed controlled. The patient died on the thirty-fourth hospital day of carcinomatosis. There

was no distention of bowel found at autopsy. The tube was removed after 11 days.

6 R.B. No. 611098 female aged 6 days. The patient was a 6-day-old baby who was admitted because of persistent vomiting and a walnut sized mass at the base of a necrotic umbilical stump. Intestinal contents drained at the umbilicus and with probing of the wound drainage became free and the emesis ceased. X-ray examination revealed complete obstruction at the cerum. The patient was treated with suction and parenteral fluids alternating with concentrated predigested food. The fistula was frequently probed to permit drainage and stop vomiting so that feeding could be done. Gangrene of the arm developed necessitating amputation. Patient expired the thirtieth hospital and second day following amputation. Autopsy revealed the fistula to be in the terminal ileum with many adhesions in this region. The adhesions apparently caused the obstruction. There was also a congenital stricture of the cystic duct.

The following case histories involve deaths related to obstruction.

7 E.R. No. 660155 male aged 54. Patient had had vague gastro intestinal distress almost all his life, more marked for the 4 to 5 years prior to admission. His pain had been constant for the 4 months prior to admission and he had been largely incapacitated. There was a history of recent red blood in the stools. The patient had had abdominal cramps, vomiting and obstipation. He had been treated in another hospital for 10 days for an intra abdominal condition the diagnosis of which was reserved. There had been shoulder strap pain for 24 hours. The patient had had appendectomy 30 years before admission. At the time of admission there was marked distention of the abdomen with extreme tenderness in the upper abdomen but no definite rebound tenderness. The abdomen was silent. X-ray examination revealed distention of small and large bowel and some loss of peritoneal markings but no free gas. Diagnosis made was possible perforated ulcer but this was indeterminate. The patient was treated conservatively with suction and transfusions. He expired on the 11th hospital day. Autopsy revealed strangulation obstruction due to visceroparietal adhesions at site of old appendectomy. There was peritonitis but no definite perforation. There was a duodenal ulcer not perforated.

8 H O, No 662246, male, aged 19 This patient had had appendectomy 6 months before admission No gross abnormality had been found On the day of the present admission the patient suffered sudden, severe abdominal pain accompanied by vomiting He had been given 2 injections of what was believed to be morphine Upon admission, examination of the abdomen revealed no distention, and the abdomen was soft There was some tenderness in the right lower quadrant with slight spasticity there The patient was heavily narcotized The abdomen was quiet to auscultation X-ray examinations were inconclusive, and the diagnosis was reserved The patient was treated conservatively and under observation The temperature rose and distention appeared and increased The patient became irrational within 48 hours (temperature 99.6 degrees R and pulse 110) and from that time on he removed the duodenal catheter frequently He died the sixth hospital day with the diagnosis of peritonitis, cause undetermined Autopsy revealed strangulation obstruction under an adhesion and peritonitis There was a Meckel's diverticulum of no note

9 A H, No 601069, female, aged 66 Patient had had a 30-year history of cholecystitis Cholelithiasis had been diagnosed by x-ray examination and surgery had been advised, but was refused She was admitted 1 year later complaining of pain in the upper abdomen and in the back This attack was of 25 days' duration at the time of admission She had medical management for 8 days during which time she had barium by mouth upon 2 occasions In the latter examination it was noted that there was a spontaneous cholecystoduodenal fistula and that the gall stones were in the pelvis They completely obstructed the flow of barium There was distention of the small bowel by gas, and the patient was transferred to the surgical service The patient was a very poor surgical risk, among other things, she had retained practically nothing by mouth for over 1 month It was hoped that the stones would pass and the patient was treated conservatively with suction, paracentral fluids, and hot packs The distention was relieved

trary, the obstruction is relieved satisfactorily and the patient survives for a reasonable period of time to die of the initial primary condition, such patients are omitted in the calculation of the "corrected mortality" Inasmuch as a few patients were obstructed more than once, both a patient and case mortality are listed

#### COMMENT

Obstruction of the bowel embraces a large number of rather diverse pathological conditions which bring about similar end-effects One of the surprising findings brought out in this review of the experience of this clinic in the treatment of acute bowel obstruction is how large a number of the patients exclusive of strangulated hernias, intussusception, and acute obstructions of the large bowel, have been treated entirely or primarily by suction There have been a few glaring mistakes made (Group 1, A, deaths Nos. 7 and 8 Group 1,

and the stones did move slightly the first few days After that, however, they remained stationary and the obstruction persisted, but was controlled by conservative management of alternating suction and feeding The patient died on the fifty-fifth hospital day, the forty-seventh day on the surgical service Autopsy revealed a cholecystoduodenal fistula and intestinal obstruction of a chronic nature due to impaction of a mass of gall stones This mass could not be moved forward or backward in the bowel Two sharp projections had perforated the bowel wall and there was localized peritonitis When the mass of stones was removed, it could not be broken by moderately vigorous manipulation There were impacted stones in the common duct

10 E C, No 615599, female, aged 52 The patient weighed 375 pounds She had a ventral hernia of 20 years' duration with a second defect of 10 years' duration, the latter the result of an attempted repair of the former The patient was admitted with a history of pain in the region of the hernias, abdominal pain of a cramp-like character, and nausea and vomiting for 6 days prior to admission Examination of the abdomen revealed obesity, 2 ventral hernias filled with bowel from which gas could be expressed There was some tenderness over the hernias There were no borborygmi noted at the acme of pain The patient's systolic blood pressure was 55 millimeters of mercury the day of admission In spite of the possibility of strangulation, it was deemed advisable to treat the patient conservatively This was done The patient expired on the third hospital day At autopsy all the small intestine was found free in the peritoneal cavity proper The hernias were filled with colon Almost all the terminal ileum was strangulated with perforation of the anti-mesenteric border in one spot There were adhesions present, most of which were not related to the peritonitis found at autopsy It was believed that strangulation had taken place in one of the hernial sacs and that the bowel had returned to the peritoneal cavity after death, judging from the findings at autopsy

C, death No 6) in extending the indications for suction<sup>1</sup> When these cases are reviewed critically in the light of the significant evidence abstracted from the case records, it is only fair to say that the fault lay largely in

<sup>1</sup>In the discussions of the Western Surgical Association for 1937 which have been printed since this paper was written is contained the suggestion that the so called conservative management of mechanical obstruction is *expectans morlem* treatment And so it may well be, when applied to unsuitable cases Yet, in the experience of this clinic, suction has proved a worth while adjunct as well as a valuable direct, single, therapeutic agent in the treatment of certain types of bowel obstruction

There have been no injuries noted in the pharynx, larynx, esophagus, or stomach of any of the patients reported in this series One patient in the series had a duodenal tube down constantly for purposes of feeding or suction for 47 days (Group 1, A, death No 10) Two patients have been observed at the University Hospital with injury to the arytenoid cartilages following prolonged intubation One of these was our own patient After drainage of the abscess the condition cleared quite satisfactorily The other patient was admitted here with edema of the arytenoid cartilages and larynx for which tracheotomy was done He, too, recovered but with residual limitation of motion of one of the vocal cords In the 7 years during which suction has been applied frequently to intubing duodenal tubes, probably more than 5,000 patients in this hospital have earned such tubes for valuable periods of time

The pathologists of the metropolitan area of the Twin Cities have been interrogated with reference to traumatic lesions from duodenal tubes at various times and none has been reported to us save an occasional small erosion of the gastric mucosa Inasmuch as our pathologists do not examine routinely the nasopharynx, larynx and upper reaches of the esophagus, it is of course not unlikely that in this region, where such pressure effects are most likely to arise, several have escaped notice

TABLE II—GROUP 1—THE SUCTION GROUP

B Patients decompressed by suction but operated upon subsequently because of demonstrated or conjectured persistence of obstructive mechanism

		Patients	Cases	Deaths	Per cent mortality		Unrelieved deaths	Corrected mortality per cent	
					Patient	Case		Patient	Case
Procedure	Pathology	17	17	1	5.9	5.9	0	3.9	5.9
Lysis of adhesions	Adhesions		1	0		0			0
Enterolysis (pneumoperitoneum) (enterotomy)	Adhesions		3	0		0			0
Resection	Adhesions about a former anastomosis; adhesions about terminal ileum; carcinomas of cecum		1	0		0			0
Exploration only	Tuberculosis peritonitis		1	0		0			0
Presacral neurectomy	Spasmodic			1		100			100
Enterotomy	Stricture		1	0		0			0
Enteroplasty	Stricture		1	0		0			0
Seen in other groups		10							

Seen subsequently in Group 1A

Seen previously in Group 1A

Three patients were morphine addicts

3

7

#### Deaths in Group 1B

1. D.K., No. 616766, female aged 32. This patient returned 3 days after having been successfully decompressed by suction. She had recurrence of symptoms and findings. There was 4 plus distention and loops of small bowel were palpable and visible. There was no tenderness or rigidity. The small bowel was completely decompressed by suction in 45 hours and suction was continued intermittently for 36 hours more. Surgery had been advised following decompression during the former admission but was refused. Surgery was accepted this time and was carried out. On

exploration no obstructive mechanism was found and the obstruction was believed to be spastic in nature. A presacral neurectomy was done. This procedure was accompanied by bleeding severe enough to warrant packing. The patient convalesced well for 4 days when she began to have fever.

The patient died suddenly on the seventh post-operative day following removal of packing. No autopsy was obtained but pulmonary embolism was believed to be the cause of death. Exploration of the wound revealed no evidence of hemorrhage.

each instance with the observers who noted the findings accurately enough but who interpreted them badly. Patients like the 3 referred to, who entered the hospital with a strangulating type of obstruction and who already had transudation of fluid into the peritoneal cavity, are less likely to have *intestinal colic* as a prominent finding than are patients with simple obstruction. Yet, careful auscultation of the abdomen at the bedside over protracted periods of time has invariably in the experience of the senior author of this paper, revealed recurrent intestinal gurgling. To be certain if the strangulation has been present for some time and if the patient has been heavily narcotized *intestinal colic* is by no means a prominent feature and it is difficult on this basis alone to decide that a strangulating obstruction is present. For even

patients with peritonitis of inflammatory origin do have intestinal gurgling occasionally. Yet the tell tale evidence of the history of gas pains and vomiting, the uniform presence of tenderness and the character of the gastric aspirations are extremely helpful. Another significant but less frequent occurrence is the unrelenting and unusually severe character of the pain which overshadows the earlier intermittent crampy pain.

This study indicates that the differential criteria which have been described to distinguish simple and strangulating obstructions are reliable. It is to be admitted freely, however, that now and then due to increase of intraluminal pressure alone the gut of simple obstruction will weep, and fluid will transude into the peritoneal cavity giving rise to abdominal tenderness. In this series of cases

TABLE III—GROUP 1—THE SUCTION GROUP

C Patients in whom suction was unsuccessful in effecting decompression and in whom operation became necessary for satisfactory relief from acute obstruction

	Patients	Cases	Deaths	Per cent mortality		Unrelated deaths	Corrected mortality per cent	
				Patient	Case		Patient	Case
Procedure	38	43	14	36.8	32.6	4	26.3	23.3
Primary enterostomy— division of a few adhesions	20	20*	2*	10	10	0	10	10
Pathology								
Adhesions	20	20*	2*					
Carcinoma	3	5**	4		80	3		20
Gall-stone impaction	1							
Hernia	1							
Primary division of adhesions with simultaneous enterostomy		5	4		80			80
Division of adhesions alone		3	0		0			0
Enterolysis		3†	1†		33.3			33.3
Enterostomy		3	0		0			0
Enterostomy		1	0		0			0
Resection		1	1		100			100
Exteriorization		1†	1		100			100
Reduction of intussusception		1†	1		100			100
Diaphragmatic hernioplasty		1	0		0			0
Exploration only		1	1		100	1		
Obstruction complete			9					
Obstruction partial			5					
Seen twice in Group C		5						
Seen in other groups	7							
Seen previously in Group 1A	5							
Seen subsequently in Group 1A	1							
Seen previously in Group 2A	1							
Classified also in Group 2 (deaths Nos. 9 and 10)		2						

\*Strangulation was present in one of the deaths (death No. 11)

\*\*One case (death No. 9) had 2 enterostomies at 2 different times (classified as 1 enterostomy)

†See death No. 7

‡During an enterostomy four days after reduction of intussusception, the patient (death No. 10) died. Peritonitis was present. The enterostomy was not completed.

#### Deaths in Group 1C

The first 4 deaths are considered as unrelated to the obstruction.

1 J.L., No. 646685, male, aged 54. This patient had been admitted 1 year before for probable alcoholic gastritis and enteritis and was treated conservatively. He was admitted with a week's history of vomiting, abdominal pain, and constipation. There was some small bowel distention which refused to clear up completely with long tube but was improved. Eleven days after admission, patient was explored with tentative diagnosis of chronic obstruction probably due to adhesions following an old appendectomy. Tuberculous peritonitis was found and biopsied. He died 13 days later of tuberculous peritonitis, atypical fibroid pulmonary tuberculosis with miliary nodules, and hypostatic pneumonia.

2 H.W., No. 646386, male, aged 37. This patient had a chronic history of over 3 weeks' duration of intestinal obstruction with a gastro intestinal study having been done outside. He was treated 6 days with suction with no relief.

The abdomen was explored and metastatic carcinoma was found. Enterostomy was done. The patient improved, then obstruction recurred and 10 days later a permanent ileostomy was done, 9 days after which the patient died. No autopsy was obtained.

3 G.S., No. 664482, female, aged 64. This patient was discharged from gynecological service 1 month before admission. At that time she had carcinoma of the ovary with metastases and had had surgery. Symptoms of obstruction present upon second admission were not relieved entirely by duodenal tube well into jejunum, so enterostomy was done 6 days after admission. Patient died 55 days later of carcinomatosis and cachexia. No distention was present at death.

4 I.F., No. 608342, female, aged 30. Patient had had radiation therapy for carcinoma of the cervix 1 year before admission. She was admitted with signs of pelvic peritonitis and obstruction, with cramp-like pain, and borborygmi present. Conservative treatment relieved the pain but distention was not completely relieved so enterostomy was

done 8 days later. The patient continued her febrile course and died 14 days later. Autopsy revealed that the carcinoma had perforated into the rectum causing the peritonitis.

The following deaths were related to obstruction:  
 5 CW No 654754 male aged 59. Onset of symptoms of obstruction occurred 5 days before admission. There were no previous operations. Patient was struck in the abdomen by a baseball many years before. A similar attack occurred 8 years before. The bowel was partially decompressed by suction (tube in duodenum next day). X-ray third and fourth days showed increased distention and the tube in the stomach. No gas in the colon so the patient was explored (fourth day). Tenderness was not noted. Bowel was too distended for exploration so enterostomy was done. Patient had 2 attacks of acute dilatation of the stomach. He died the ninth postoperative day of peritonitis atelectasis and hydrothorax. Autopsy showed obstruction to be due to an adhesive band 16 inches below the enterostomy. Exploration rather than blind enterostomy would have obviated outcome.

6 MS No 663126 female aged 56. The patient was admitted with a 36 hour history of cramp-like abdominal pain and constipation with similar attacks over the preceding few years. The abdomen was very tender and distended at the time of admission. There was no rectal tenderness. Temperature 100 degrees pulse 126 respiration 20. She was treated conservatively. The next morning (14 hours after admission) temperature was 103.4 (R) pulse 140 respirations 22 and abdomen was tender. Exploration (2 hours duration) revealed strangulation of the distal 6 feet of ileum by an adhesive band across the mesentery. Bowel could not be exteriorized because cecum would not deliver so the distal end was resected and the cecum dropped back and the ileum was brought out with a Fayr clamp and an enterostomy was done on the exteriorized segment. Patient died 12 hours later. The temperature had risen to 106 patient was cyanotic and gasping for breath. Ten minutes before death much fluid was aspirated from trachea and pharynx. Autopsy was refused. I prolonged operative procedure contributed materially to outcome.

7 EM No 661383 female aged 13. This patient had had appendectomy for ruptured appendix and 18 days later she developed obstruction and an enterostomy was done. She was discharged in satisfactory condition. Three weeks later she was admitted with strangulation obstruction due to adhesive bands which were divided and an enterostomy was done. Convalescence was satisfactory and pneumoperitoneum was done 9 days later. Sixteen days after enterostomy the obstruction recurred. Conservative treatment was carried on for 24 hours but the abdomen remained tender and rigid so patient was explored at which time no obstruction was found. There was fibrosis on the peritoneum and loops of bowel were adherent to each other. Enterolysis was done. The patient developed a gangrenous wound infection with a doubtful positive culture for gas bacillus and died the second postoperative day.

8 ON No 665195 male aged 52. The patient presented a 3 weeks history of cramp-like abdominal pain vomiting and constipation and had lost 25 pounds in weight. He was followed 2 days in the Out patient Department where he was thought to be a psychoneurotic. He was transferred to surgery the day after admission with complete decompression accomplished in 3 days but the obstruction recurred after ingestion of fluid and so the patient was explored 6 days after admission. The obstruction was found and was thought to be due to carcinoma inflammation or foreign body in the terminal ileum. In attempting to free it up the bowel was accidentally perforated with resultant spillage. Enterostomy was done. The patient died of peritonitis and bronchopneumonia 6

days later. Simple enterostomy would have avoided this unfortunate occurrence.

9 FB No 633028 male aged 57. The patient was admitted with a one week's history of distention occasional abdominal pain (crampy) and constipation. There was an incisional hernia of 8 years duration partially reducible. X-ray examination revealed distention of bowel. He was given 24 hours of conservative treatment with decrease in distention of bowel. Under local anesthesia a needle then a trocar then a catheter were inserted into the bowel in the hernial sac and purse string sutures were taken about the catheter. No relief was obtained by this combined with suction. Five days later an enterostomy was done. The patient died the next day with a picture of circulatory collapse. Autopsy was done and revealed gangrenous small bowel and hepatic flexure with perforation of both in the hernial sac. Enterostomy on strangulated segment failed to relieve because of presence of hernia in W (de Beule).

10 LC No 610990 female aged 27. The patient spoke only Mexican and was 4 to 5 months pregnant. History was of cramp-like abdominal pain and vomiting of 3 days duration. Suction was instituted and fluids were given. After 24 hours rebound tenderness appeared, distention had not decreased. The abdomen was explored and an enteric intussusception was reduced. Cultures taken at time of reduction showed peritonitis to be present. Suction was continued. Patient did not improve appreciably and 4 days later became more distended. An enterostomy under local anesthesia supplemented by ethylene was attempted. Patient died suddenly on the table. Peritonitis was present and was the cause of death. There was active tuberculosis in both apices at autopsy. No perforation was found but bowel wall was thinner than normal and the mucosa was ulcerated.

11 JD No 637736 male aged 34. The patient was admitted 7 months after appendectomy for ruptured appendix. The history was 16 hours of crampy abdominal pain nausea and obstipation of sudden onset. Examination of the abdomen revealed tenderness no peristaltic rushes and no distention of note. Conservative treatment was employed without relief for 2 days when rebound tenderness appeared. Patient was explored and strangulation obstruction due to adhesive bands was found and some (but not all) of bands were freed and an enterostomy was done. Patient died 40 hours later with gas bacillus infection of right chest wall (jaundiced). Autopsy revealed gas bacillus infection peritonitis and strangulation obstruction of lower 8 to 10 feet of ileum caused by an adhesive band across the mesentery. The discovery of the strangulation mechanism entailed 45 minutes of searching at autopsy.

12 FC No 6240 female aged 60. Seventeen days prior to admission the patient had black stools and was placed on a milk and cream diet. Four days later she felt ill and had abdominal cramps. She ate no food for 3 days when she resumed her diet. Distention along with intermittent pain was noted a week prior to admission. Distention continued to the time of admission. Two days before admission an enema was given with no results. Abdomen was distended there was no tenderness or borborygmi. Diagnosis was probable spastic ileus. Conservative treatment was employed for 24 hours without relief. Duodenal tube would not enter duodenum even with the fluoroscope as a guide. Abdomen was explored under spinal anesthesia and gas was found in the colon. No obstruction was found but sterile fluid was present. Enterostomy was done. (At the time of admission there was no elevation of white blood count hemoglobin reported 65 per cent and 49 per cent.) Patient died 4 days later. Autopsy revealed

a mass of white stool in the sigmoid colon with perforation, hemorrhage, and beginning peritonitis. No obstruction was found but there was ileus. Acute duodenal ulcer and atelectasis of both lower lobes were found. This was in all probability a case of spastic ileus of the colon with perforation.

13 J.A., No. 643016, male, aged 73. This patient presented a 9 day history of obstruction. There was a 4 plus distention. He was treated conservatively for 17 days with no improvement, so was explored. Cholecystenteric fistula with gall-stone impaction in the terminal ileum was found. The gall stone was removed and enterostomy was done. Spinal anesthesia was used and resuscitation was necessary at the completion of the operation. He died suddenly the evening of operation, apparently a delayed spinal anesthesia death. See also below Table IV, Case 2.<sup>1</sup>

<sup>1</sup>For more than 4 years now inhalation anesthesia has been employed in all operations for acute intestinal obstruction save in a few instances

14 M.F., No. 611402, male, 22. This patient had cramp-like abdominal pain, nausea, and vomiting for 4 days prior to admission. Appendectomy (drained) had been done 1 year before. Abdomen was 3 plus distended and there was some rebound tenderness. He was treated conservatively for 2 days and the tube was in the duodenum, bowel was partially decompressed. His temperature had risen to 101 degrees F., and there was some rebound tenderness. No gas was in the colon as determined by x-ray examination. The abdomen was explored and a loop of small bowel was found pinched off by an adhesion, but the blood supply was satisfactory. Spillage occurred in dividing the adhesion. The perforation was sutured and an enterostomy was done. The patient died 3 days later of peritonitis.

in which local infiltration with procaine was employed. The patient's stomach is evacuated with an indwelling duodenal tube before as well as during operation.

there have been quite a number in which this occurrence was observed during the course of suction treatment. As soon as tenderness supervenes (which should be looked for by experienced examiners every 4 to 6 hours), operation should be done. No deaths occurred in such cases in this series and no disappointment was felt in failing to find a strangulating type of obstruction. The only reason that has been justified for treating patients with acute obstruction of the small bowel presenting abdominal tenderness conservatively has been repeated obstruction in the same patient.<sup>2</sup> A few such patients appear in this series, none of whom came to harm through this apparent unwarranted departure from established procedure. The only defense for this seeming liberty is the anxiety of the surgeon to postpone operation in such instances until the more complete operation of enterolysis can be done in an unobstructive phase. The persistence of tenderness in such instances, however, indicates that operation is in order, an occurrence which has urged operative intervention occasionally in this type of case.

It is not as easy to define exactly the contraindications for continuance of suction or the criteria which suggest necessity for operation in simple acute obstruction of the small intestine as it is for strangulating obstructions or acute occlusion of the colon with great distention. Disappearance of gaseous distention of the small intestine and reappearance of gas in

the colon (in complete obstruction) herald a successful issue. The consideration which must be kept in mind always is that the longer suction is continued, the greater hazard to the patient if suction fails. The importance of effecting a happy compromise between achieving decompression by suction within a reasonable period or resorting to operative relief is, therefore, the wisest rule to follow. Postponed operations will mean operations of necessity (enterostomy) rather than operations of election. Yet, our own experience with enterostomy in late, adhesive, non-strangulating obstructions has been satisfactory (Table III).

#### DUODENAL INTUBATION

Our practice has been to introduce the catheter into the stomach. Suction is then applied and the patient is placed in various positions until it is reasonably certain that the stomach has been evacuated. The source of suction is then temporarily cut off, the patient is requested to drink a glass of water and is placed in the lateral decubitus with the right side down. The duodenal tube is advanced about an inch every 5 minutes. After about 30 minutes the cut-off on the suction is released and if the intestinal distention has not been great enough to divert the course of the tube, it is observed usually that bile is aspirated. It is a good plan at this juncture to fluoroscope the patient or take a bedside film to check on the position of the tube. In the main, this method has been quite as successful for the catheterization of the pyloric

<sup>2</sup>Two female patients with plastic pelvic masses, which caused protracted intestinal obstruction, were treated successfully by inducing hyperpyrexia in a fever chamber, suction being maintained over long periods to an indwelling duodenal tube. Operative intervention in such instances not uncommonly extends the peritoneal infection.

dome 8 days later. The patient continued her febrile course and died 14 days later. Autopsy revealed that the carcinoma had perforated into the rectum causing the peritonitis. The following deaths were related to obstruction.

5 C.W. No 054754 male aged 59. Onset of symptoms of obstruction occurred 5 days before admission. There were no previous operations. Patient was struck in the abdomen by a baseball many years before. A similar attack occurred 8 years before. The bowel was partially decompressed by suction (tube in duodenum next day). X ray third and fourth days showed increased distention and the tube in the stomach. No gas in the colon so the patient was explored (fourth day). Tenderness was not noted. Bowel was too distended for exploration so enterostomy was done. Patient had 2 attacks of acute dilatation of the stomach. He died the ninth postoperative day of peritonitis atelectasis and hydrothorax. Autopsy showed obstruction to be due to an adhesive band 16 inches below the enterostomy. Exploration rather than blind enterostomy would have obviated outcome.

6 M.S. No 603126 female aged 56. The patient was admitted with a 36 hour history of cramp-like abdominal pain and constipation with similar attacks over the preceding few years. The abdomen was very tender and distended at the time of admission, there was no rectal tenderness. Temperature 100 degrees pulse 126 respiration 20. She was treated conservatively. The next morning (14 hours after admission) temperature was 103.4 (R) pulse 140 respiration 22 and abdomen was tender. Exploration (2 hours duration) revealed strangulation of the distal 6 feet of ileum by an adhesive band across the mesentery. Bowel could not be exteriorized because cecum would not deliver so the distal end was resected and the cecum dropped back and the ileum was brought out with a Payr clamp and an enterostomy was done on the exteriorized ileum. Patient died 12 hours later. The temperature had risen to 106 patient was cyanotic and gasping for breath. Ten minutes before death much fluid was aspirated from trachea and pharynx. Autopsy was refused. Prolonged operative procedure contributed materially to outcome.

7 E.M. No 601383 female aged 13. This patient had had appendectomy for ruptured appendix and 18 days later she developed obstruction and an enterostomy was done. She was discharged in satisfactory condition. Three weeks later she was admitted with strangulation obstruction due to adhesive bands which were divided and an enterostomy was done. Convalescence was satisfactory and pneumoperitoneum was done 9 days later. Sixteen days after enterostomy the obstruction recurred. Conservative treatment was carried on for 24 hours but the abdomen remained tender and rigid so patient was explored at which time no obstruction was found. There was firm on the peritoneum and loops of bowel were adherent to each other. Enterolysis was done. The patient developed a gangrenous wound infection with a doubtful positive culture for gas bacillus and died the second postoperative day.

8 G.N. No 605195 male aged 42. The patient presented a 3 weeks history of cramp-like abdominal pain vomiting and constipation and had lost 25 pounds in weight. He was followed 2 days in the Out patient Department where he was thought to be a psychoneurotic. He was transferred to surgery the day after admission with complete decompression accomplished in 3 days, but the obstruction recurred after ingestion of fluid and so the patient was explored 6 days after admission. The obstruction was found and was thought to be due to carcinoma inflammation or foreign body in the terminal ileum. In attempting to free it up the bowel was accidentally perforated with resultant spillage. Enterostomy was done. The patient died of peritonitis and bronchopneumonia 6

days later. Simple enterostomy would have avoided this unfortunate occurrence.

9 F.B. No 613028 male aged 57. The patient was admitted with a one week's history of distention occasional abdominal pain (crampy) and constipation. There was an incisional hernia of 8 years duration partially reducible. X ray examination revealed distention of bowel. He was given 24 hours of conservative treatment with decrease in distention of bowel. Under local anesthesia a needle then a trocar then a catheter were inserted into the bowel in the hernial sac and purse string sutures were taken about the catheter. No relief was obtained by this combined with suction. Five days later an enterostomy was done. The patient died the next day with a picture of circulatory collapse. Autopsy was done and revealed gangrenous small bowel and hepatic flexure with perforation of both in the hernial sac. Enterostomy on strangulated segment failed to relieve because of presence of hernia in (de Beule).

10 L.C. No 610990 female aged 27. The patient spoke only Mexican and was 4 to 5 months pregnant. History was of cramp-like abdominal pain and vomiting of 3 days duration. Suction was instituted and fluids were given. After 24 hours rebound tenderness appeared distention had not decreased. The abdomen was explored and an enteric intussusception was reduced. Cultures taken at time of reduction showed peritonitis to be present. Suction was continued. Patient did not improve appreciably and 4 days later became more distended. An enterostomy under local anesthesia supplemented by ethylene was attempted patient died suddenly on the table. Peritonitis was present and was the cause of death. There was active tuberculosis in both apices at autopsy. No perforation was found but bowel wall was thinner than normal and the mucosa was ulcerated.

11 J.D. No 627736 male aged 34. The patient was admitted 7 months after appendectomy for ruptured appendix. The history was 16 hours of crampy abdominal pain nausea and obstipation of sudden onset. Examination of the abdomen revealed tenderness no peristalsis, rushes and no distention of note. Conservative treatment was employed without relief for 2 days when rebound tenderness appeared. Patient was explored and strangulation obstruction due to adhesive bands was found and some (but not all) of bands were freed and an enterostomy was done. Patient died 40 hours later with gas bacillus infection of right chest wall (pneumothorax). Autopsy revealed gas bacillus infection peritonitis and strangulation obstruction of lower 8 to 10 feet of ileum caused by an adhesive band across the mesentery. The discovery of the strangulation mechanism entailed 45 minutes of searching at autopsy.

12 E.C. No 61470 female aged 60. Seventeen days prior to admission the patient had black stools and was placed on a milk and cream diet. Four days later she felt ill and had abdominal cramps. She ate no food for 3 days when she resumed her diet. Distention along with intermittent pain was noted a week prior to admission. Distention continued to the time of admission. Two days before admission an enema was given with no results. Abdomen was distended there was no tenderness or borborygmi. Diagnosis was probable spastic ileus. Conservative treatment was employed for 24 hours without relief. Duodenal tube would not enter duodenum even with the fluoroscope as a guide. Abdomen was explored under spinal anesthesia and gas was found in the colon. No obstruction was found but sterile fluid was present. Enterostomy was done. (At the time of admission there was no elevation of white blood count hemoglobin reported 95 per cent and 49 per cent.) Patient died 4 days later. Autopsy revealed

TABLE V—GROUP 2—PATIENTS TREATED BY IMMEDIATE OPERATION

## B Strangulated or incarcerated hernias

	Patients	Cases	Deaths	Per cent mortality		Unrelated deaths	Corrected mortality per cent	
				Patient	Case		Patient	Case
Incarcerated hernias	45	47	9	20	19.1	0	20	19.1
	17	18	0	0	0	0	0	0
Strangulated hernias	28	29	9	32.1	31	0	32.1	31
Procedure done in cases of strangulation								
Simple reduction and hernioplasty		19	2		10.5			10.5
Suturing over small gangrenous area		3	1		33.3			33.3
Suturing over small gangrenous area and enterostomy		2	1		50			50
Exteriorization		3	3		100			100
Enterostomy		1	1		100			100
Conservative therapy using suction		1	1		100			100
Femoral hernias		17	1		5.9			5.9
Inguinal hernias		17	1		5.9			5.9
Incisional hernias		12	7		58.3			58.3
Diaphragmatic hernias		1	0		0			0
Hernias of Richter's type		4	4		0			0
Seen twice in Group 2B	2							
Also classified in Group 1C (one of which is death No. 9)	2							
Also classified in Group 1A (death No. 8)	1							

## Deaths in Group 2B

All deaths are considered as related to the obstruction.

1 A R, No 663930, female, aged 55. Patient had a 24 hour history of vomiting and of pain in an incisional hernia which she was unable to reduce. At the time of admission her systolic blood pressure was 80 millimeters of mercury and bronchopneumonia was present. She was given a blood transfusion and intravenous fluids before operation. Slight cyanosis was present when the operation was begun. The strangulated ileum was reduced and the normal color of the bowel returned. The patient was placed in an oxygen tent after operation and a blood transfusion and parenteral fluids were given. She improved temporarily, but died the evening of operation. Autopsy showed hypertensive heart with dilation of the right ventricle, edema of the lungs, and bronchopneumonia.

2 C W, No 632311, female, aged 53. Patient had an incisional hernia which had been incarcerated for 1 month. She had had pain, nausea, and vomiting for several days before admission. At operation there was gangrene of 15 centimeters of ileum, perforation had occurred and the gangrenous bowel was exteriorized and an enterostomy was done on the proximal loop. She died 21 days after operation of sepsis following parotid abscess, submental abscess, and wound infection.

3 M D, No 640364, female, aged 51. This patient had a femoral hernia which had been incarcerated for 3 days before admission. At operation the bowel was strangulated, but was thought to be viable. The patient died the day following operation of peritonitis, atelectasis, and bronchopneumonia. No perforation was found at autopsy, but there were small areas of focal necrosis of the bowel wall.

4 J B, No 663086, female, aged 47. Patient had had 4 abdominal operations, 3 of which were for intestinal ob-

struction. She had had abdominal pain and vomiting for 7 hours before surgery. She had an incisional hernia in which the ileum was incarcerated. Two feet of the ileum were gangrenous, strangulation was caused by an adhesive band in the hernial sac. The gangrenous bowel was exteriorized. Convalescence was stormy but satisfactory until the seventh day when the patient's temperature and pulse rose very high and she expired. Autopsy examination done through the operative incision did not reveal enough peritonitis to warrant death, the immediate cause of death was thought to be bronchopneumonia.

5 J R, No 651256, female, aged 76. Patient had a strangulated incisional hernia. The hernia was surgically reduced and an enterostomy was done proximal to the strangulated segments of bowel. Auricular fibrillation was noted the second postoperative day. Death was due to cardiac failure (left and right) and bronchopneumonia occurred the fifth postoperative day.

6 J T, No 659832, male, aged 67. This man spoke no English. According to the history obtained, the patient was stepped on by a cow 5 days prior to admission. An incarcerated inguinal hernia was present and the patient was in a state of shock. Eight hours were spent combating the shock. At operation the bowel was found to be strangulated and perforated and peritonitis was present. He died on the first postoperative day.

7 N J, No 654542, female, aged 64. This patient had a femoral hernia with strangulation and gangrene of a loop of ileum and a Meckel's diverticulum. The loop was exteriorized. The patient died the fifth postoperative day of peritonitis and pulmonary atelectasis.

8 See Group 1A, death No. 10, in which the patient had 2 ventral hernias.

9 See Group 1C, death No. 9, a case in which enterostomy on strangulated segment failed.



TABLE IV.—GROUP 2.—PATIENTS TREATED BY IMMEDIATE OILRATION

## A. Intraperitoneal obstructions

Procedure	Enterostomy	Pathologic Adhesions	Patients	Cases	Deaths	Percent mortality		Unrelated deaths	Corrected mortality percent	
						Patient	Case		Patient	Case
Enterostomy			5	5	1	40	33.3	1	20	16.6
Enterostomy		St. agglutination due to adhesions		4	1		25	1		0
Enterostomy		St. agglutination due to adhesions		1	1		100	0		100
Enterostomy		St. agglutination due to adhesions		1	0		0	0		0

One patient was later seen in Group C

## Deaths in Group 2 A

Death No. 1 is considered as unrelated to the obstruction. A.H. No. 59766 female aged 74. Patient had a long history of constipation and diarrhea. She had had rather severe lower abdominal pain, obstipation and vomiting for 12 days before admission. Examination revealed marked distention of the abdomen with rebound tenderness in the lower abdomen. A hard nodular mass was palpable per rectum. The abdomen was explored and the ileum was found obstructed by adhesions about a mass in the pelvis. Enterostomy was done. The patient had a stormy course and died the eighth postoperative day of pelvic peritonitis due to perforation of a sigmoid diverticulum.

The following deaths were related to obstruction. A.P. No. 61350, female aged 60. This patient had acute crampy colicky abdominal pain of 36 hours duration. Examination upon admission revealed abdominal rigidity with marked lower abdominal tenderness. A diagnosis of intra abdominal strangulation was made and

the patient was operated upon immediately. Spinal anesthesia was used. The patient was somewhat cyanotic at the time of operation and the systolic blood pressure was 80 millimeters of mercury. About 3 feet of strangulated small bowel were exteriorized and resected. Strangulation was caused by an adhesive band secondary to an old hernioplasty. The patient stopped breathing and became comatose during the operation. Resuscitation measures and scald and blood were given and the patient left the operating room in fair condition. The patient did not respond following surgery and never regained consciousness. Blood pressure and pulse however were satisfactory. She died the second postoperative day. Autopsy revealed pulmonary arteriosclerosis and congestion and some injection of the peritoneal surfaces. Cultures of the abdominal fluid taken at the time of operation were positive for *Bacillus coli*. The immediate cause of death obviously was the reaction attending employment of spinal anesthesia similar to case No. 64306.

outlet as has introduction of the tube by fluoroscopic visualization. In the presence of great distention it may be difficult or impossible to get beyond the pyloric sphincter by any method.

## THE DEMANDS OF SUCTION TREATMENT

The observations which it is necessary to make during the course of conservative decompression of instances of mechanical obstruction of the small bowel have been repeated so often that they will merely be enumerated here. The importance of roentgenographic, check up, scout films of the abdomen cannot be overestimated. If the increments of swallowed air and fluid dumped in at the upper reaches of the gut are being withdrawn through the agency of an oblique duodenal tube even if there be no satisfactory reduction of the existing distention, the patient often will cease to complain of pain because there is no accretion of distention

It is decidedly unsafe, therefore, to employ suction without periodic check up films. Usually a film every 12 hours will suffice but in an occasional case a film may have to be taken every 4 to 6 hours while it is being decided whether operative interference will be necessary. Patients treated for mechanical obstruction are given no narcotics. Hot moist packs, however are applied over the abdomen.

It would appear needless to remark that a liberal para-oral administration of saline solution is in order in all patients with acute bowel obstruction in which the fluid loss item has been great. That it is even more important when suction is employed as a therapeutic agent is self evident. Yet the experience of seeing patients inadequately hydrated in consultation suggests that this consideration is not given the attention which it merits. Careful daily determination of the fluid loss (gastric aspirations) and urinary output are more

TABLE VII—GROUP 3—MISCELLANEOUS GROUP—NO THERAPY DIRECTED AT RELIEF OF OBSTRUCTION

Patients moribund or dead on arrival at the ward, the obstruction had righted itself spontaneously, or presence of obstruction was not recognized

	Patients	Cases	Deaths	Per cent mortality		Unrelated deaths	Corrected mortality per cent	
				Patient	Case		Patient	Case
	16	16	6	37.5	37.5	1	33.3	33.3
Pathology								
Adhesions		7	2		28.6	1		16.6
Hernias		7	3		42.8			42.8
Carcinoma*		1	0		0			0
Mesenteric embolism		1	1		100			100

\*The patient who had probable carcinoma refused surgery and was discharged against advice

#### Deaths in Group 3

Death No. 1 is considered as unrelated to the obstruction.  
1 M C, No 650106, male, aged 47. This patient died 6 days after pneumonectomy for carcinoma of the lung. Small bowel obstruction (not strangulated) was found at autopsy.

The following deaths were related to the obstruction.

2 J R, No 64679, male, aged 56. The patient had a 36 hour history of prostration and emesis of fecal character. He expired while being transported to the ward. Autopsy revealed complete obstruction of the ileum by adhesions and acute dilatation of the stomach. The cause of death was hypochloremia.

3 E L, No 648123, female, aged 52. This patient was admitted after 3 days of vomiting, and diagnosis of strangulated inguinal hernia was made. The patient was in a state of profound shock at the time of admission. The shock was combatted unsuccessfully and the patient died 24 hours after admission. At autopsy strangulation was revealed.

4 H N, No 660199, female, aged 56. This woman had a 10 months' history of ascites, paracentesis had been done 4 times. Four months before admission the patient noted a persistent abdominal mass. She experienced sudden pain

in the abdomen and was brought to the hospital in an apathetic, comatose state, suggesting cerebral accident, an incarcerated ventral hernia was present. The patient's condition was considered too poor for surgery. She expired the third hospital day. Autopsy showed cirrhosis of the liver and strangulated incisional hernia.

5 J P, No 668085, male, aged 69. The patient had an incisional hernia and within the year prior to admission had 2 bouts of vomiting and abdominal pain. A third attack appeared and the patient was sent to the University Hospitals. While on the way he vomited and expired immediately. He was dead upon arrival. Autopsy revealed aspiration asphyxia and a strangulated incisional hernia.

6 E W, No 669216, female, aged 58. This patient had known rheumatic valvular heart disease. She had had intermittent attacks of abdominal pain questionably related to intake of foods. Two weeks before admission she vomited several times. Three days prior to admission she became comatose. A diagnosis of mesenteric embolism was made upon admission. She expired the day after admission and an auricular mural thrombus with embolism of the superior mesenteric artery and infarction of the small intestine and right half of the colon were found at autopsy. Peritonitis was generalized.

daily in which the presence of sodium chloride can be demonstrated.

The treatment of intestinal distention no matter what the cause should be passive as far as the patient is concerned. The administration of drugs which enhance peristaltic activity is out of place in the management of mechanical obstructions, so also in physiological types of ileus due to intestinal paresis. The latter type of case without exception has been treated solely by suction in this clinic for over 7 years, and the number of instances in which suction has been unsuccessful has been very small.

It was for the relief of this type of distention that Ward (26, 27) suggested and em-

ployed suction in 1925. It seems now not a little unusual that it required the demonstration of the efficacy of suction in the management of mechanical obstruction to lend the propelling impetus to the general adoption of this mode of management for physiological distentions. The story of the use of the duodenal tube in the relief of intestinal distention has been told very interestingly by Paine (16).

The advent of the double lumen tube (1, 9) with the balloon at the tip to facilitate migration down the gut, once the duodenum has been entered, will pyramid undoubtedly the usefulness of suction in such cases. Another increasingly important use of the Miller-

TABLE VI—GROUP 2—PATIENTS TREATED BY IMMEDIATE OPERATION

## C. Intussusception

	Patients	Cases	Deaths	Per cent mortality		Unrelated deaths	Corrected mortality per cent	
				Patient	Case		Patient	Case
Procedure	15	15	6	60	40	0	40	40
Reduction		13	5		41.7			41.7
Ileocolostomy		5	1		100			100
Found reduced by barium enema		1	0		0			0
Ligation over hard rubber tube*		5	0		0			0

\* (Case of rectocolic intussusception)

Reduced on barium enema was attempted in 10 cases. The intussusception was partially reduced in 8 cases. In one of these reductions a mass was found to be complete at the time of operation. In another case reduction was complete several times but the intussusception recurred each time and reduction was done surgically.

Mekel's diverticulum was present in 1 case.

One case (death No. 4) is also classed in Group C.

## Deaths in Group 2C

All deaths are considered as related to the obstruction. B. B. M. No. 63576 male, aged 4 months. This child had a typical history and findings of intussusception with a mass palpable both abdominally and rectally. He was operated upon immediately after admission within 24 hours of onset. A colicocolic and an ileocecal intussusception were both readily reduced. The patient had a rather stormy course the basis for which did not appear to be in the abdomen or chest. He died the seventeenth postoperative day of bronchopneumonia and mastoiditis. There was no peritonitis.

B. R. No. 60667 female aged 4 months. The patient was breast fed for 2½ months and was then given feedings of boiled whole cow's milk half and half with a 100 per cent carbohydrate syrup. About a week later the child developed diarrhea, vomiting and fever and had lost 6 pounds at the time of admission. 3 weeks after onset of symptoms. The baby showed marked signs of recent weight loss and was febrile. She was treated on the pediatric service as a case of nutritional disturbance and otitis media. Five days after admission bloody stools were noted. The next day they were again noted, the abdomen was distended, but the child showed no sign of pain. Tenderness was not elicited. A mass was felt per rectum and the patient was operated upon. Death occurred as the peritoneum was opened. An ileocecal intussusception was found. Had the child lived enterocolic anastomosis would have been necessary because of gangrene. The intussusception seemed to have been present about 3 to 4 days.

J. M. T. No. 60613 female aged 6 months. This patient had a 40 hour history of intussusception which was reduced by surgery shortly after admission. About 2 inches

of terminal ileum and cecum were blue after reduction but resection was deemed inadvisable. The child died 16 days after operation of perforation of the cecum with localized peritonitis, bilateral otitis media, wound infection and bronchopneumonia.

M. F. No. 637430 female aged 2 years. A rather typical history of intussusception had been present for 36 hours before the patient was admitted. Physical findings were typical. Surgery was done immediately. An ileocecal intussusception was found, this could not be reduced so an ileocolostomy was done. The postoperative course was very stormy for 7 days at which time the patient's temperature fell to 100 degrees F. The ninth postoperative day the patient eviscerated the two eviscerated loops of bowel were replaced and the wound was taped. The patient died of peritonitis the twelfth postoperative day. At autopsy the non-reducible ileum was gangrenous.

C. M. No. 651505 male aged 2½ years. This boy had an 18 hour history of cramp like colicky abdominal pain and vomiting. Upon admission a mass was palpable in the right lower quadrant of the abdomen. This was palpable rectally. The mass was quite tender but there was no tenderness elsewhere. The abdomen was silent. The patient was operated upon without delay. The pre-operative diagnosis was intussusception, volvulus or intra-abdominal hernia. A compound enteric intussusception was found this was partially reduced when the patient's blood pressure suddenly became unobtainable. The patient had been receiving intravenous fluid during the entire procedure. Blood was given and the involved bowel was quickly exteriorized but resuscitation measures failed.

L. C. No. 610990 female aged 27 (See death No. 10 (Group C)).

significant than the tallying of the pulse rate and the recording of the temperature. When will these items be recorded on the face sheet of all hospital records for the orientation of the surgeon? Orr has lent particular consideration to the fluid requirements of patients with bowel obstruction. Collet and his associates have defined the fluid requirements of

surgical patients of all types. An excellent review of this aspect of the problem incorporating the practice of the Ann Arbor group has been made by Bartlett, Bingham and Pedersen which is deserving of careful study. In our clinic enough fluid has been given parenterally to patients with obstruction to provide 800 to 1000 cubic centimeters of urine

tunately, decline to operate on many of these patients with formidable, incisional hernias when they are unobstructed. Grave as the situation appears, this study would indicate that all patients with strangulated, incisional hernias should be operated on at once, the discouraging magnitude of the undertaking in a seriously ill patient to the contrary notwithstanding.<sup>1</sup>

In this series there is one strangulated internal hernia (diaphragmatic—pleuroperitoneal hiatus) treated conservatively for a period somewhat longer than 12 hours, during which time suction improved the respiratory embarrassment considerably. It is our opinion that suction is of more value than preliminary phrenicectomy as suggested by Harrington (6, 7) in preparing the patient for operation and in minimizing compromise of the blood supply of the strangulated gut. Placement of the patient in various positions to prevent aspiration of the gas and fluid trapped in the stomach above the diaphragm is usually important. In the instance of a complete diaphragmatic rupture observed and successfully treated since June 1 of this year, preliminary suction was a helpful agent in diminishing dyspnea and cyanosis as well as distention before operation. There probably is more justification for treating an internal obstructed hernia conservatively for a few hours before operation than an external hernia in which the strangulating agent is less yielding.

Another feature brought out by this study, to which allusion has been made on previous occasions, is the infrequency with which early postoperative obstructions occur after abdominal operation when suction is used prophylactically to obviate intestinal distention, a practice of this clinic, the continuance of which this review justifies.

In patients with simple obstruction due to adhesions not decompressed satisfactorily by suction, enterostomy is still the operation of choice. The findings of our study support this contention. In a group of 20 such patients—and these represent the worst types of simple obstruction caused by adhesions—suction failed and enterostomy was done

TABLE VIII—SUMMARY OF MORTALITY OF ACUTE MECHANICAL OBSTRUCTION OF SMALL INTESTINE.

	No of deaths		No of deaths related to obstruction		Mortality per cent	
	Pa-tients	Cases	Pa-tients	Cases	Pa-tients	Cases
All treated cases	156	190	28	28	17.9	14.7
All cases treated by suction	96	126	15	15	15.6	11.9
Cases decompressed by suction (Group 1, A and B)	64	83	5	5	7.8	6.0

There were 2 deaths, both due to the limitations of "blind enterostomy." In one (Table III, death No. 2) a complicated, strangulating type of mechanism was uncovered at autopsy; in the other (Table III, death No. 5) a single adhesive band had brought about compression necrosis of the gut. Simple division of it undoubtedly would have obviated this occurrence. Yet, it would not have been found without eviscerating the strangulated gut, a procedure which is not justified as a frequent operative measure in the light of the recorded observations of Morton (12) and of Ochsner and Storck. Holden, however, endorses it enthusiastically. There is, to be sure, no fool-proof procedure which may be applied to all types of cases. Our own experience indicates that enterostomy is a good operation for non-strangulated obstruction. Had the gut been eviscerated and stripped in this group of 20 cases in which suction failed, the mortality no doubt would have been much higher.

Division of single adhesions is a commendable procedure, but division of complicated multiple adhesions is dangerous and unwarranted as is well shown in Table III. The performance of entero-anastomosis, in the main, has little place in the treatment of acute intestinal obstruction, though it appears occasionally to be the wisest choice of procedure. The thoughtful paper of Morton (13) concerning the surgical management of acute bowel obstruction merits attentive perusal by every surgeon interested in the subject.

#### THE MORTALITY OF TREATMENT

There is to be reckoned with in the obstruction problem a sizeable mortality in the very

<sup>1</sup>Division of the constricting bands without repair of the hernia would appear to be the procedure of choice.

Abbott type of tube will be found to be in the identification of unobstructive lesions of the small bowel. The experience of this clinic with a tube of double lumen extends back to 1932, but the excellent suggestion of Miller, Abbott, and Johnston to employ an inflatable balloon in conjunction therewith has been tried only during the last 6 months covered by this period of study. One of us (Dr. Baxter A. Smith) has during this period of time been trying to evaluate the comparative merits of the usual duodenal tube with the balloon type of double lumen tube. In Table IX the experiences with mechanical obstructions and a few other types of cases are summarized briefly. Although our experience in the main, with the double lumen tube has been reassuring, it has not yet been extensive enough to establish valid comparisons. It would appear unsettled and somewhat doubtful if the indications for conservative decompression in mechanical obstruction were to be extended materially by use of the tube of the Miller-Abbott type beyond those outlined by the senior author in 1931 (18).

Instances of colonic obstruction in which distention of the large bowel is not great may probably be decompressed more often by the entry of such a tube into the cecum. Yet, during the time of this study (not included in this series, for suction in the management of mechanical obstruction concerns essentially the small bowel) 6 patients with acute colonic obstruction with lesser grades of distention were treated successfully by suction alone, a direct surgical attack being made later on the obstructing mechanism. Einhorn, McClendon (10, 11), van der Reis and Schomburg have succeeded in passing the ordinary duodenal tube down into the lower reaches of the bowel. Though we have frequently been successful in pushing the usual duodenal tube well into the obstructed small intestine, its progression beyond the pyloric sphincter is slow, as contrasted with the balloon type of tube.

#### OTHER AUXILIARY CONSERVATIVE TREATMENT

The work of Fine and his associates has established the value of oxygen in the treatment of intestinal distention. Unless used in

combination with suction, however, the method probably has little worth. Suction is so much more a direct approach to the problem of relieving the distention of the mechanical intestinal obstruction that the administration of oxygen in high concentration is probably only of secondary import. In inhibition (paralytic) types of ileus, it has a much more proper indication.

The administration of blood to patients with strangulating types of obstruction in whom the blood loss factor may be great is mandatory and has not been used enough even in this series as is indicated by this critical review of our own experience. Death No. 5 in Table VI (intussusception) was due undoubtedly to failure to replace blood by transfusion and in death No. 2 it was an important though somewhat less significant item in the light of the antecedent history. It is also likely that transfusion of blood would be a helpful therapeutic measure in all simple obstructions accompanied by transudation of fluid into the peritoneal cavity, even though the protein content of such fluid is low.<sup>1</sup>

### SPECIAL LESSONS TAUGHT BY THIS METHOD

Apart from failure to recognize strangulating obstructions, which have been described above as a pitfall of the conservative management of acute obstruction of the small intestine and failure to transfuse patients adequately with strangulating types of obstruction, the most startling observation revealed by this study is the great risk run by patients with strangulated incisional hernias. The necessity for operating on such patients needs no emphasis. In this series one feeble obese patient was treated unsuccessfully by suction alone (Table I death No. 10). Another was temporized with for 24 hours and then an enterostomy was made on a loop of gut in one of the sacs in the abdominal wall which was also a futile gesture (Table III death No. 9). Many of these patients are marked for death on entry to the hospital. Most of us, unfor-

12. *Just like with high grade antenutrition I doubt there is a decrease of venous pressure in the left low cecum. It is not a permanent increase in the left low cecum. The arterial pressure was observed that the venous pressure in the left low cecum was decreased. A common factor, but it is not a factor in the left low cecum. It is not a factor in the left low cecum. (C. J. Ellis 10 H W. Greenstein, L. Paul, and others)*

nature of the disease, but the mortality of treatment must be evaluated critically, too. It exists in every clinic and anyone having to do with the care of patients may contribute to it. It relates to the improper identification of disorders, unwise choice of therapeutic agent, and poorly selected as well as badly executed operative procedures. Enterostomy, in the presence of obstruction must be done carefully and aseptically. There would, as a matter of fact, be no mortality in simple obstructions, if adequate relief of distention could be obtained without peritoneal soiling. Witness the low mortality attending conservative decompression of acute simple obstruction (Table I). If those patients in satisfactory physical condition needing operation could be relieved of their distention, maintaining at the same time, the sterility of the peritoneal cavity, the mortality would be minimal. The experience of this clinic with aseptic surgical decompression of the colon acutely obstructed by malignancy substantiates this opinion (21). In strangulating obstructions not submitted to early operation, the mortality will continue to be high because of the hazard of transperitoneal migration of noxious substances, particularly bacteria, from the obstructed gut lumen.

#### SUMMARY

The experience of this clinic with all types of mechanical obstruction of the small bowel over the 7 year interval between June 1, 1931, and June 1, 1938, has been reviewed. This experience is related in detail in the tables and is summarized briefly in Table VIII. The indications and contra-indications for the suction management of mechanical obstructions described in 1931 have been reiterated and the lessons learned in the intervening years have been reviewed.

Among 156 patients treated for acute mechanical obstruction of the small intestine, there were because of repetition of obstruction in some patients, 190 cases. There were 28 deaths in the entire group, a patient mortality of 17.9 per cent and a case mortality of 14.7 per cent.

In Group 1, the assembly of cases in which suction was the primary treatment (though in

a portion of these, Group 1C, operation became necessary to effect a satisfactory decompression), there were 96 patients and 126 cases of obstruction. There were 15 deaths, a patient mortality of 15.6 per cent and a case mortality of 11.9 per cent. In those instances in which suction alone accomplished a satisfactory decompression (Group 1, A and B) and relief of the acute obstruction, there were 64 patients and 83 cases. Five deaths occurred, giving a patient mortality of 7.8 per cent and a case mortality of 6 per cent.

The suction group constitutes 61.5 per cent by patient and 66.3 per cent by case of all patients treated for acute mechanical obstruction of the small intestine during the period under study. The number in which suction alone was the only direct attack employed for the relief of acute obstruction (Group 1, A and B) was 41 per cent by patient and 43.6 per cent by case of the entire group.

#### CONCLUSIONS

Suction applied to an inlying duodenal tube has a definite rôle in the treatment of acute mechanical obstruction of the intestine. In suitable cases, complete relief of obstruction may be obtained through this agent alone. In a far larger group, suction is to be employed solely as an ancillary procedure, subordinate in importance to operative decompression or direct attack on the obstructive mechanism.

The intelligent use of suction in the relief of acute intestinal obstruction rests upon the following.

1. Ability to differentiate simple and strangulating types of obstruction.
2. Ability to distinguish between acute obstruction of the large and small bowel.
3. Appreciation of the importance of scout x-ray films for indicating the location of the obstruction and whether it is complete or incomplete, and for determining whether a satisfactory decompression is being obtained.
4. Appreciation of the shortcomings of suction applied to an inlying duodenal tube in the management of acute intestinal obstruction.

The experience of this clinic with the use of suction in the management of obstruction

TABLE IV.—COMPARATIVE EFFICACY OF VARIOUS TYPES OF DUODENAL TUBES IN EFFECTING DECOMPRESSION

Number	Working diagnosis	Type of tube*	How long tried	Time before any tube entered duodenum	Followed by	Length of tube passed beyond duodenum	Time and effort expended	Course	Result of decompression
1 N B 666311	Mechanical obstruction Small bowel obstruction due to adhesions	(b) 4	46 hrs 4 hrs	45 hrs	X-ray	6 ft	4 das moderate effort	Recovery	Satisfactory
2 G C 667531	Small bowel obstruction due to gonorrheal pelvic inflammatory disease	4 5	19 hrs 5 hrs	24 hrs	X-ray	4 ft	4 das moderate effort	Recovery	Satisfactory
3 C S 668733	Small bowel obstruction due to adhesions	4 3	9 hrs 21 hrs	20 hrs	X-ray and fluoroscope	25 in	22 hrs little effort	Recovery	Satisfactory
4 B S 669050	Small bowel obstruction due to adhesions	(b) 4	4 hrs	4 hrs	Fluoroscope	5 ft	4 hrs constant effort	Recovery	Satisfactory
5 D H 669957	Small bowel obstruction probably due to tuberculous pelvic inflammatory disease	4	4 hrs	4 hrs	X-ray	5 ft	14 hrs moderate effort	Recovery	Satisfactory
6 J L 669861 Group 1, C Death No	Partial small bowel obstruction probably malignant	4 2	6 das h	6 das	X-ray	3 ft	3 hrs constant effort	Death	Unsatisfactory but no improvement
7 E R 669933 Group 1, A Death No 7	Generalized peritonitis	(a) 5	44 hrs 1 hr	1 hr	X-ray	2 ft	4 hrs constant effort	Death	Unsatisfactory
8 G S 669928	Chronic small bowel obstruction	(a) 4	25 min	5 min	Fluoroscope	5 ft	2 hrs constant effort	Recovery	Satisfactory
9 M K 667035	Small bowel obstruction etiology undetermined	4	15 hrs	15 hrs	X-ray	35 ft	24 hrs little effort	Recovery	Satisfactory
10 O M 667954 Group 1, A Death No 5	Carcinoma with small bowel obstruction	4	4 hrs	4 hrs	X-ray	3 ft	48 hrs moderate effort	Death	Satisfactory
11 L A 666788	Carcinoma with small bowel obstruction	(a) 4	4 das 30 min	4 das	X-ray	5 ft	4 hrs constant effort	Death	Satisfactory
12 N B 666531 Observed since 8-1-33	Small bowel obstruction due to adhesions	4	3 das	Never	X-ray and fluoroscope		Constant moderate effort	Recovery	Unsatisfactory & eventually done
13 N S 667093	Postoperative ileus Postoperative ileus pulmonary atelectasis	3	4 hrs	1 hr	X-ray	2 ft	8 hrs moderate effort	Recovery	Satisfactory
14 C H 667563	Postoperative ileus	(b) 4	22 hrs	4 hrs	X-ray	3 ft	4 hrs moderate effort	Recovery	Satisfactory
15 H R 668590	Paralytic ileus	(c) 5	0 das	N.v.	X-ray		Moderate	Death	Unsatisfactory
16 S E 67335	Diagnosed Perforated Perforated carcinoma of jejunum			(1b) T be followed beyond 11 of a perforated in B num rected p in 11 the balloon of m n in rect carcinoma					
17 E P 672070	Postoperative ileus Small bowel obstruction			(1b) T be followed to cecum the tube was gradually withdrawn & removed in 1 p h 1 hr		6 hours B n m rected proximal to the balloon			

\*Types of T be

- (1) M H Abbott tube (b) Long double lumen tube of arrow construct in usually the same as the M H Abbott tube  
Long double lumen tube with a metal ball leader a small rubber balloon 1/2 in. attached to the end of the balloon by a 3-inch piece of  
5 ft. silk thread  
(2) T be made of (b) except that the top 1/2 in. is covered with tulle  
(3) T be made of (b) except that the top 1/2 in. is covered with tulle  
(4) T be made of (b) except that the top 1/2 in. is covered with tulle  
(5) T be made of (b) except that the top 1/2 in. is covered with tulle  
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(25) T be made of (b) except that the top 1/2 in. is covered with tulle  
(26) T be made of (b) except that the top 1/2 in. is covered with tulle  
(27) T be made of (b) except that the top 1/2 in. is covered with tulle  
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(29) T be made of (b) except that the top 1/2 in. is covered with tulle  
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\*Patient ultimately died of carcinoma in situ. Terminal ileitis obstructa reappeared 4 years after operation. The tube was used for 10 days.

# THE PREVENTION OF MATERNAL AND INFANT ANEMIA

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THE association of pregnancy and anemia is so common that one may almost feel inclined to consider a moderate degree of anemia during pregnancy as a physiologic condition. Goodall and Gottlieb in an analysis of two hundred consecutive, non-selected cases of pregnancy were able to show that during pregnancy there is a definite tendency toward the development of a progressive hypochromic anemia; that this anemia becomes most pronounced in the third trimester, and is most severe in cases in which pregnancies succeed one another in rapid order. They also found a diminution or even complete disappearance of free hydrochloric acid in the later months of gestation and a strong tendency to a return to the normal postpartum.

In a previous publication (6) we were able to show the close relationship of maternal and fetal erythropoiesis. Paradoxically enough, it was found that the greater the anemia of the mother, the greater fetal polycythemia. This was explained by the fact that the anemia of the mother intensifies the existing anoxemia of the fetus (5) which is compensated for by an increase in the number of erythrocytes. Strauss (2) was able to show that infants born of anemic mothers, although normal at birth, develop anemia during the first year of life and that this anemia could be prevented by the oral administration of iron.

Realizing the importance of preventing the development of anemia with all its complications during pregnancy, we proceeded to study the effect of preventative therapy on the mother, and later, the infant. We were soon, however, faced with another problem. The easily upset gastro-intestinal tract of pregnant women was greatly upset with different preparations of iron in general use.

This paper deals with a hematological study of 525 consecutive, non-selected cases of pregnancy. Of these 275 cases received no therapy, while 250 were treated with different iron preparations. In 100 cases the infants were also studied. Fifty of these infants were born of mothers who had no therapy, while in the other 50 cases the mother had received iron.

## METHOD

In all patients examined complete hematological examinations were made on the mothers when first seen, usually during the second or third month of pregnancy, and the examinations repeated at intervals until delivery. In the patients who received treatment, re-examinations were made for some time postpartum. In the 100 cases in which the infants were studied, the blood was examined at birth (cord blood) and at intervals for 8 months after birth. Only average figures of the findings are given to save space.

## RESULTS

*Group 1.* This group comprised the 275 untreated cases. The average amount of hemoglobin was 75 per cent—10.50 grams. The reduction was most marked in the third trimester. The averages were first trimester, 80 per cent—11.20 grams, second trimester, 75 per cent—10.50 grams; third trimester, 65 per cent—9.10 grams. The hemoglobin reductions are most marked in multiparous women who had had pregnancies in rapid succession.

The red blood cells were also reduced in all cases, but not as markedly as the hemoglobin.

Microcytes were usually present and the number of reticulocytes increased, depending upon the degree of the anemia.

*Group 2.* In this group 250 cases were treated with different iron preparations. The hemoglobin values in this group ranged from

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suggests that when employed on suitable indications and with full realization of its weaknesses and defects, it is a worth while addition to the available therapeutic agents, and that its rational use should lead to a definite, general lowering of the mortality of acute intestinal obstruction.

The conservative decompression mode of management is a painstaking procedure which demands meticulous attention to detail. The limitations of the method demand also that patients accepted for treatment be passed upon by trained observers. Frequent periodic resurvey of the status of a patient being treated conservatively is mandatory. The consistently best results in the treatment of acute intestinal obstruction will be obtained in hospital practice when the management of all such cases is concentrated in the hands of a few individuals who are interested in and willing to devote time and energy which such cases should rightfully command.

#### REFERENCES

1. ABBOTT W O and JOHNSTON C C Intubation studies of human small intestine non surgical method of treating localizing and diagnosing nature of obstructive lesions Surg Gynec & Obst 1935 66 691-697
2. BARTLETT ROBERT M BINGHAM DERMID L C and PEDERSEN SVEVD Salt balance in surgical patients Surgery 1935 4 441 September and p 614 October
3. COLLIER F A BARTLETT ROBERT M BINGHAM DERMID L C MADDOCK WALTER G and PROF SVEVD The replacement of sodium chloride in surgical patients Ann Surg 1935 103 709
4. FINNHORN MAX An intestinal tube N York M J 1919 110 456
5. FINE J BANKS BM and HERMANSON L The treatment of gaseous distention of the intestine by the inhalation of 95 per cent oxygen description of an apparatus for the clinical administration of high oxygen mixtures Ann Surg 1935 103 375
6. HARRINGTON S W Diaphragmatic hernia Arch Surg 1913 16 336
7. Idem Diaphragmatic hernia associated with traumatic gastric erosion and ulcer Surg Gynec & Obst 1930 51 503
8. HOLDEY W B Intestinal obstruction 135 personal cases Arch Surg 1926 10 836
9. JOHNSTON CHARLES G PENSERTY GROVER C and R J and KENNING J C Decompression of the small intestine in the treatment of intestinal obstruction J Am M Ass 1935 111 1305
10. McCLENDON J F BISSELL F C LOWE F R and MEYER P F Hydrogen ion concentration of the contents of the small intestine J Am M Ass 1930 73 1618
11. McCLENDON J F and MEDES G Physical Chemistry in Biology and Medicine P 202 Philadelphia W B Saunders 1925
12. MOATON J J The treatment of ileus as indicated by clinical experience and experimental studies Ann Surg 1932 95 856
13. Idem Factors determining the selection of operation in obstruction of the small intestine Surgery 1937 1 845
14. OCHSNER A and STORCK A H Mechanical decompression of intestine in treatment of ileus effect of stripping on blood pressure Arch Surg 1936 33 664
15. ORR THOMAS G The therapeutic management of intestinal obstruction Surgery 1937 1 838
16. PAYNE J R The history of the invention and development of the stomach and duodenal tubes Ann Int Med 1934 3 752
17. VAN DER REITS and SCHREIBER F W Weitere Studien ueber die funktionelle Darmlage Operative Ergebnisse und Beobachtungen am Bauchfenster Ztschr f d ges exper Med 1926 52 74
18. WANGENSTEEN O H The early diagnosis of acute intestinal obstruction with comments on pathology and treatment With a report of successful decompression of 3 cases of mechanical bowel obstruction by nasogastric suction siphonage West J Surg Obst & Gynec 1932 40 1 also Trans West Surg Ass 1931
19. Idem Therapeutic considerations in the management of acute intestinal obstruction technique of enterostomy and a further account of decompression by the employment of suction siphonage by nasal catheter Arch Surg 1935 26 933
20. Idem The management of acute intestinal obstruction with special mention of the character of the vomiting and distention J Lancet 1934 54 640
21. Idem Rationalizing treatment of acute intestinal obstructions Surg Gynec & Obst 1937 64 273
22. Idem Acute bowel obstruction its recognition and management New England J Med 1918 210 340
23. Idem Bowel Obstructions Springfield Illinois Charles C Thomas 1937
24. WANGENSTEEN O H and PAYNE J P Nasogastric suction siphonage its uses and the technique of its employment Minnesota Med 1933 13 96
25. Idem Treatment of acute intestinal obstruction by suction with the duodenal tube J Am M Ass 1933 101 1332
26. WARD R Apparatus for continuous gastric or duodenal lavage J Am M Ass 1925 84 1114
27. Idem Acute dilation of stomach Am J Surg 1930 9 1294

## DISCUSSION

The development of an iron deficiency during pregnancy is easy to understand if one considers that the fetus not only develops its own blood supply during the intra-uterine life, but actually develops a polycythemia during its prenatal stage, to overcome the normal degree of anoxemia in which it has to live before birth. The iron for the production of hemoglobin (3) must be supplied from the iron storage of the mother. These iron requirements are rather large. Bunge has shown that the livers of young animals contain weight for weight about five times the quantity of iron that is found in adult livers. The greater polycythemia in the fetuses of anemic, untreated mothers is essential for the maintenance of the oxygenation of the fetal tissues, but the iron storage of these fetuses is apparently deficient and the infant obviously cannot maintain its normal erythrocyte and hemoglobin level during the first year of its most rapid growth and development.

Our study shows that the anemia of the mothers as well as of the infants can be easily prevented. We feel that this fact is of great clinical importance. Many maternal complications could be prevented and the infant mortality reduced.

## CONCLUSIONS

- 1 Maternal anemia is associated with a greater fetal polycythemia
- 2 Infants of anemic mothers develop anemia during the first year of life
- 3 Both the maternal anemia and the anemia of infants can be prevented by prophylactic iron therapy
- 4 Many iron preparations are effective but produce considerable gastro-intestinal upset
- 5 Ferrous sulphate in combination with vitamin B complex was found to be very effective without greatly upsetting the gastro-intestinal tract

## BIBLIOGRAPHY

- 1 BUNGE, G Hoppe-Seyl Z, 1892, 13 399
- 2 CASTLE, W B, and STRAUSS, M B Anæmia of pregnancy Am J M Sc, 1933, 185 539
- 3 GOLDBLOOM, A, and GOTTLIEB, R Icterus neonatorum Am J Dis Child, 1929, 38 57 Studies on icterus neonatorum, the product of icterus in animals following prolonged anoxæmia J Clin Invest, 1930, 8 375 Icterus neonatorum 3 the oxygen capacity and saturation of the mother and fetus J Clin Invest, 1930, 9 139
- 4 GOODALL, J R, and GOTTLIEB, R The association of pregnancy, hypochromic anæmia and achlorhydria Canadian M Ass J, 1936, 35 50
- 5 GOTTLIEB, R, and KEARNS, P J Icterus neonatorum 4 the rôle of the placenta in visible icterus neonatorum J Clin Invest, 1931, 10. 319
- 6 STREAN G J, and GOTTLIEB, R The relationship of maternal anæmia to foetal polycythaemia Canad'an M Ass J, 1936, 35 261

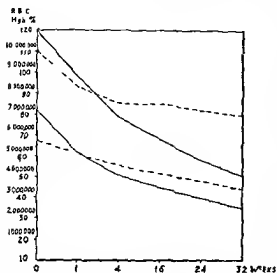


Chart 1 Straight line represents red blood cells and hemoglobin of infants whose mothers did not receive iron. Interrupted lines red blood cells and hemoglobin of infants whose mothers received iron.

58 per cent—8.12 grams to 80 per cent—11.20 grams. The erythrocytes ranged from 3,600,000 to 4,300,000. In dividing the therapy among 250 cases, special care was taken to select the patients in such a way that each group would show about the same average findings.

1. Fifty patients were treated with ferri et ammonium citrate, of which 30 grains were given three times daily. Elixir lactopepsin was used as a vehicle. The results in this group were excellent and normal values were reached in 4 weeks. These values were maintained throughout the pregnancy with very little variation. There was a slight drop in the hemoglobin after delivery, but this was rapidly restored. However 38 of the 50 cases 76 per cent showed a good deal of gastro intestinal upset.

2. Fifty patients were treated with ferrous carbonate and copper in the combination of 6 grains of ferrous carbonate and 1/48 grains of copper. This amount was given three times daily. The results in this group were fairly good. However, the response was not as rapid as in the previous group. Approximately normal values were reached in 6 weeks. A slight drop in the hemoglobin after delivery

was rapidly restored. The gastro intestinal upsets, on the other hand, were less marked and only 24 cases in 50, 48 per cent, showed upset. In 25 cases 1/12 grains of phenol phthalein was added but there was no appreciable difference in the number of gastro intestinal upsets, 11 patients showed reaction in the group without phenolphthalein and 13 patients in the group with phenolphthalein.

3. Fifty patients were treated with reduced iron of which 5 grains were given three times daily. The results were about equal to those obtained with ferrous carbonate. Normal hemoglobin values were reached in 5 weeks and a slight drop in hemoglobin after delivery was restored in a short time. There were less cases with gastro intestinal upset, 18 of the 50 cases, 36 per cent, showed upsets.

4. One hundred patients were treated with ferrous sulphate, grains 3, combined with vitamin B derived from yeast concentrate.<sup>1</sup> A total of 15 grains were given daily. Preference was given to this preparation because there were very few gastric upsets. Only 5 of the 100 patients, 5 per cent, showed some disturbances. The results obtained were equal to those with ferri et ammonium citrate. Normal values were reached in 4 weeks and a slight drop after delivery was rapidly restored.

Group 3. This group comprises 50 infants, whose mothers had not received any iron therapy and 50 infants whose mothers had received iron. A striking difference in the blood of these infants was found.

In the treated group the average number of erythrocytes at birth was 7,450,000 and the average amount of hemoglobin 120 per cent—16.80 grams. While in the treated group the average number of erythrocytes was only 5,290,000 and the average amount of hemoglobin 111 per cent—15.44 grams. At the end of 32 weeks however the picture was just reversed. In the untreated group the average number of erythrocytes was 860,000 and the average amount of hemoglobin 51 per cent—7.14 grams. The treatment group had an average erythrocyte count of 4,300,000 and an average amount of hemoglobin of 82 per cent—11.48 grams. Chart 1 shows the relation of these two groups of infants.

<sup>1</sup>Supplied in the form of hematogen.

TABLE I—FIVE YEAR SURVIVALS BY AGE

Age in years	Total number	Survivals number	per cent
30-39	5	4	80.0
40-49	36	19	52.8
50-59	49	26	53.1
60-69	26	17	65.4
70-79	4	1	25.0
Total	120	67	55.8

TABLE II—FIVE YEAR SURVIVALS BY GRADE OF MALIGNANCY

Grade of malignancy	Total number	Survivals number	per cent
1	19	15	78.9
2	72	41	56.9
3 and 4	29	11	37.9
Total	120	67	55.8

TABLE III—INVOLVEMENT OF LYMPH NODES BY GRADE OF MALIGNANCY

Grade of malignancy	Total number	With involvement of lymph nodes number	per cent
1	19	3	15.8
2	72	23	31.9
3	23	15	65.2
4	6	6	100.0
Total	120	47	39.2

one passes to the higher grades of malignancy. They found, too, that the prognostic influence of nodal involvement operates quite as well in any one grade as in the entire group. The present figures are in agreement with all of these observations (Tables II, III, and IV).

The prognostic importance of lymph node involvement considered alone is illustrated in Table V. Whereas in this series 44.7 per cent of the patients with lymph node involvement were alive 5 years or more after operation, it is interesting to note that in 1923 Miller stated that there is no reason to believe that any patient with lymph node metastasis can survive and that, therefore, excision of the growth itself is all that ever need be done.

Karsner and Clark, in a series of 104 cases, noted a decreasing frequency of lymph node metastases as one progressed from left to right in the colon. In the present series, on the contrary, the frequency increases from left to right (Table VI).

Ochsenhirt, in a study of 188 cases, found that secretion of mucus by the carcinoma cell is a function indicating differentiation and

TABLE IV.—INVOLVEMENT OF LYMPH NODES AND FIVE YEAR SURVIVALS—CASES SHOWING GRADE 2 OF MALIGNANCY

Lymph nodes	Total number	Survivals number	per cent
Not involved	49	29	59.2
Involved	23	12	52.2
Total	72	41	56.9

TABLE V—FIVE YEAR SURVIVALS ACCORDING TO INVOLVEMENT OF LYMPH NODES

Lymph nodes	Total number	Survivals number	per cent
Not involved	73	46	63.0
Involved	47	21	44.7
Total	120	67	55.8

TABLE VI—INVOLVEMENT OF LYMPH NODES BY LOCATION OF GROWTH

Location	Total number	With involvement of lymph nodes number	per cent
Right part of colon	28	14	50.0
Transverse	15	6	40.0
Descending	26	12	46.2
Sigmoid	51	15	29.4
Total	120	47	39.2

that the percentage of mucus-secreting cells is inversely proportional to the malignancy. Rankin and Olson in their series found essentially no prognostic difference between the mucous adenocarcinomas and the adenocarcinomas in general. Therefore, no separate classification was made for this group in the present study.

In regard to the mechanism of penetration of the cancer cell, Ewing stated, "The disease arises usually in a circumscribed area of mucosa in which the glands become enlarged, the lining cells hypertrophied and multiplied, the production of mucous cells increased, and the lumina elongated and bifurcated. The neoplastic alveoli soon break through the muscularis mucosa and extend along the submucosa, often reaching the surface at lateral points, thus extending the lesion or penetrating the muscularis along lymph or blood channels" (Fig 1).

Cole, studying rectal carcinoma, stated that the initial carcinomatous focus is covered by unbroken epithelium and surface ulceration may thereafter take place (1) by the under-

# THE MURAL PENETRATION OF THE CARCINOMA CELL IN THE COLON ANATOMIC AND CLINICAL STUDY

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THE importance of carcinoma of the colon is attested by the frequency of its occurrence. At least 10 individuals out of each 100,000 population die of carcinoma of the colon every year. This study is concerned not primarily with those 10 individuals who die, but with that group of patients who undergo a resection of their carcinoma bearing bowel and survive. Analyses of the factors concerned in their survival will be presented and an approach in the classification of these carcinomas which appears to throw some light on the prognosis will be proposed.

The cases on which this study is based comprise 120 patients selected from those treated at The Mayo Clinic in the years 1928, 1929 and 1930. All of them were patients from whom single carcinomas of the colon were removed, in whom no evidence of distant metastasis was present at the time of operation, and who survived the operation and were dismissed from the clinic with apparently good chances of cure. In all of these cases follow up information is available covering a period of 5 years or more.

In all but 30 of these cases the histological grade of malignancy by Broders method had been recorded already. These remaining specimens were therefore graded and the grading was checked by Dr Broders (1, 2). Information regarding the presence or absence of lymph node involvement was available from the pathological reports on the fresh specimens. This information was accepted without further study of the specimens.

Of these 120 patients from whom carcinomas of the colon had been removed, 67, or 55.8 per cent, lived at least 5 years after oper-

ation. What factors then determine which cases are to fall in this fortunate group?

MacCarty, studying carcinomas of the stomach, breast, and rectum, observed a uniform prolongation of postoperative life in the presence of lymphocytic infiltration, fibrosis, hyalinization, and cellular differentiation, and suggested that the first 3 factors play a significant role as part of the natural defense mechanism against carcinoma after it has once developed.

Rankin and Olson pointed out that such local conditions as fixation, perforation, and abscess formation affect operability, but are merely local influencing factors which are usually the result of prolonged neglect in the absence of symptoms or of intense activity of the carcinomatous cell. In a group of 453 cases they noted a better prognosis for growths of the right side of the colon than of the left. This observation does not correspond to the figures in the present smaller series, where 5 year survivals are noted in 53.6 per cent of carcinomas of the right half of the colon, 46.7 per cent of the transverse part of the colon, 62.3 per cent of the descending part of the colon, and 51.1 per cent of the sigmoid.

They also noted a better prognosis in the older age groups and suggested that age is a factor by virtue of a decreased activity of the tissue cells of the host, not of the cancer. In the present series (Table I) the greatest number of patients was between 40 and 69 years of age. Among these the prognosis was somewhat better between 50 and 59 years than between 40 and 49 years and considerably better between 60 and 69 years.

Rankin and Olson also noted a direct relationship between the grade of malignancy and the survival period, the outlook being progressively worse as the grade of malignancy increased. They also noted a progressive increase in the involvement of lymph nodes as

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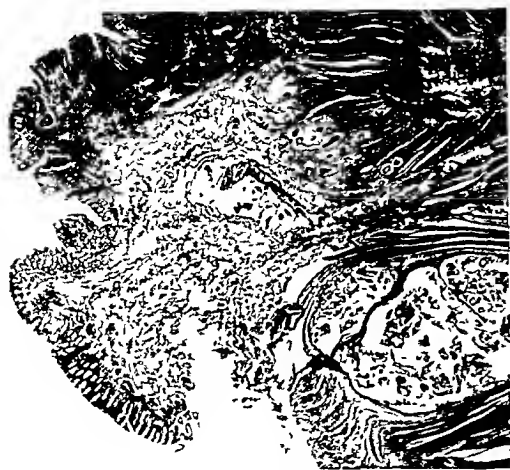


Fig 1 Lateral mucosal spread of carcinoma cells by multiple foci. Carcinoma cells have also penetrated through the muscularis and are invading the serosal fat  $\times 73$

21, or 17.5 per cent, belong to class B, and 89, or 74.2 per cent, belong to class C.

The prognosis is observed to be best in class A, with all 10 patients reported alive 5 years after the operation. The worst prognosis is observed in class C, in which a 49.4 per cent 5 year survival is found, and the intermediate prognosis is observed in class B, with a 5 year survival rate of 61.9 per cent.

In Dukes' (4) study of rectal carcinoma, his class C includes those growths that have penetrated the perirectal tissues and involved the regional lymph nodes.

Table VIII suggests a definite relation between the degree of mural penetration and the



Fig 3 Class B, grade 2, nodes positive. A female aged 53 years had symptoms of 36 months' duration, 5 year survival. Cancer cells in but not through muscularis  $\times 35$



Fig 2 Class A, grade 2, nodes positive. A male aged 42 years, had symptoms of 6 months' duration, 5 year survival. Cancer has not spread beyond the muscularis mucosa, but there is a focus of polymorphonuclear leucocytes in the serosa  $\times 34$

presence of lymph node involvement in carcinoma of the colon above the rectosigmoid.

When the average duration of symptoms is compared in the 3 classes (Table IX), it is seen that the symptoms have been present for the shortest time in class B, longer in class C, and longest in class A. This apparent paradox is explained by the fact that class A includes those polypoid growths of low invasive qualities that have given the symptom of bleeding periodically, often for many years.

Except for the preponderance of grade 1 cases in class A, the majority of all classes of cases is found to be in grade 2, the majority of all grades is in class C (Table X). These 2

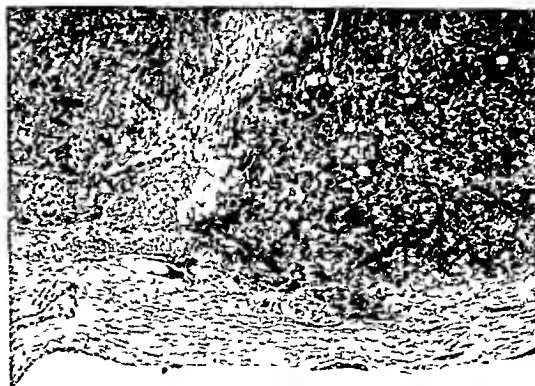


Fig 4 Class C, grade 4, nodes positive. A male aged 61 years had symptoms of 4 months' duration, 5 year survival. Carcinoma cells are directly under the peritoneum  $\times 425$

TABLE VII—FIVE YEAR SURVIVALS BY DEGREE OF MURAL PENETRATION

Degree of mural penetration	Total number	Survivals number	Survivals per cent
A	10	10	100.0
B	21	15	61.9
C	89	44	49.4
Total	120	69	57.5

TABLE VIII—MURAL PENETRATION AND INVOLVEMENT OF LYMPH NODES

Degree of mural penetration	Total number	With involvement of lymph nodes number	per cent
A	10	1	10.0
B	21	8	38.1
C	89	38	42.7
Total	120	47	39.2

mining of successive portions of the mucous membrane, or (2) by the direct involvement of overlying mucous membrane by upgrowths of carcinoma into and replacing the membrane (Fig 1) Welch expressed the opinion that the cancer spreads, so far as the mucosa is concerned, by the progressive transformation of normal into neoplastic cells as if some malign influence were passing by direct contagion to the normal cells.

Rankin and Olson found a significantly larger proportion of 5 year survivals among those cases in which the dominant direction of the growth was toward the lumen rather than among those in which the dominant direction was toward the serosa. Gray in studying cases of carcinoma of the stomach found serosal involvement to be a finding of grave prognostic import. Cuthbert Dukes (4, 5) studying carcinoma of the rectum observed that the degree of penetration of the carcinoma cell into and beyond the rectal wall was of prognostic importance comparable to that attributable to the grade of malignancy. (12) It seemed, therefore, that a similar situation might exist with regard to carcinoma of the colon above the rectosigmoid, and it was to clarify this point that the present study was undertaken.

#### METHOD OF STUDY

The specimens of the 120 carcinomas of the colon included in this study had been preserved in a 10 per cent solution of formalin

TABLE IX—AVERAGE DURATION OF SYMPTOMS ACCORDING TO DEGREE OF MURAL PENETRATION

Degree of mural penetration	Average duration months	Number of cases
A	34	10
B	9	9
C	12	81
Total	12+	100

\*D duration not stated in all case record

TABLE X—MURAL PENETRATION IN RELATION TO GRADE OF MALIGNANCY

Degree of mural penetration	Grade of Malignancy								Total
	1		2		3		4		
	num-ber	per-cent	num-ber	per-cent	num-ber	per-cent	num-ber	per-cent	
A	7	70.0	2	20.0	1	10.0	0	0	10
B	8	64.5	15	78.4	2	9.5	1	4.5	26
C	0	10.5	31	51.8	20	23.5	5	3.6	56
Total	10		48		23		6		87

A series of thin slices was made through the tumor from within outward. A thin block of tissue was removed from the region of deepest penetration. This was embedded, sectioned and stained with hematoxylin and eosin. These sections were studied and the degree to which the carcinoma cells had penetrated the intestinal wall was determined. Employing a system of classification somewhat similar to that which Dukes (4) found to be of significance in carcinoma of the rectum, but of necessity modified to conform to different anatomical circumstances, the specimens were divided into classes A, B, and C, depending on the degree of mural penetration of the cancer cells. In class A were placed those cases in which the cancer cells had not penetrated beyond the submucosa (Fig 2). In class B were placed those cases in which the cancer cells had penetrated into but not beyond the muscularis (Fig 3). In class C were placed those cases in which the cancer cells had penetrated through the muscularis and into the subperitoneal fatty and fibrous tissue of the serosa (Fig 4).

Table VII indicates that of 120 resected carcinomas 10, or 8.3 per cent, belong to class A,

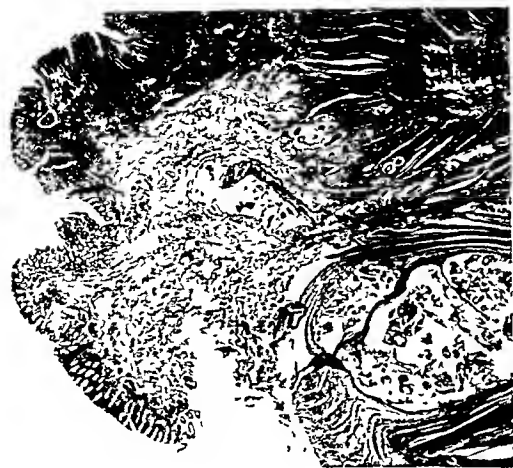


Fig 1 Lateral mucosal spread of carcinoma cells by multiple foci. Carcinoma cells have also penetrated through the muscularis and are invading the serosal fat  $\times 73$



Fig 2 Class A, grade 2, nodes positive. A male aged 42 years, had symptoms of 6 months' duration, 5 year survival. Cancer has not spread beyond the muscularis mucosa, but there is a focus of polymorphonuclear leucocytes in the serosa  $\times 34$

21, or 17.5 per cent, belong to class B, and 89, or 74.2 per cent, belong to class C.

The prognosis is observed to be best in class A, with all 10 patients reported alive 5 years after the operation. The worst prognosis is observed in class C, in which a 49.4 per cent 5 year survival is found, and the intermediate prognosis is observed in class B, with a 5 year survival rate of 61.9 per cent.

In Dukes' (4) study of rectal carcinoma, his class C includes those growths that have penetrated the perirectal tissues and involved the regional lymph nodes.

Table VIII suggests a definite relation between the degree of mural penetration and the

presence of lymph node involvement in carcinoma of the colon above the rectosigmoid.

When the average duration of symptoms is compared in the 3 classes (Table IX), it is seen that the symptoms have been present for the shortest time in class B, longer in class C, and longest in class A. This apparent paradox is explained by the fact that class A includes those polypoid growths of low invasive qualities that have given the symptom of bleeding periodically, often for many years.

Except for the preponderance of grade 1 cases in class A, the majority of all classes of cases is found to be in grade 2, the majority of all grades is in class C (Table X). These 2



Fig 3 Class B, grade 2, nodes positive. A female aged 53 years had symptoms of 36 months' duration, 5 year survival. Cancer cells in but not through muscularis  $\times 35$

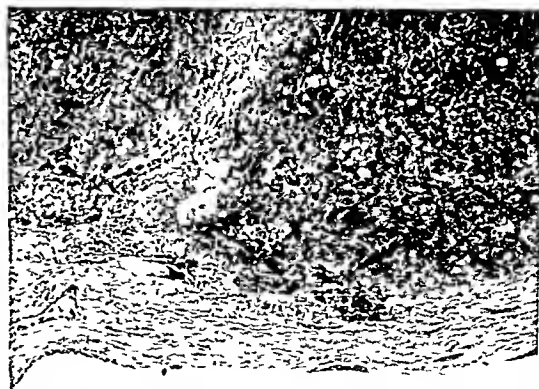


Fig 4 Class C, grade 4, nodes positive. A male aged 61 years had symptoms of 4 months' duration, 5 year survival. Carcinoma cells are directly under the peritoneum  $\times 425$



TABLE XI—FIVE YEAR SURVIVALS BY GRADE OF MALIGNANCY—CASES SHOWING DEGREE C OF MURAL PENETRATION

Grade of malignancy	Total number	Survivors number	Survivors per cent
1	9	6	66.7
2	55	29	52.7
3 and 4	25	9	36.0
Total	89	44	49.4

TABLE XII—FIVE YEAR SURVIVALS BY DEGREE OF MURAL PENETRATION—CASES SHOWING GRADE 2 OF MALIGNANCY

Degree of mural penetration	Total number	Survivors number	Survivors per cent
A	2	2	100.0
B	15	10	66.7
C	55	29	52.7
Total	72	41	56.9

groups were therefore analyzed separately as to the survival period (Tables XI and XII).

These comparisons demonstrate that in the large series of grade 2 growths, where most of the cases are to be found the percentage of 5 year survivals is directly dependent on the degree of mural penetration, being greatest in class A and least in class C. This fact offers a means of further individualizing the prognosis in this large group.

Similarly in the large group of class C cases the outlook follows the line that is predictable by the grade of malignancy, being poorest in grades 3 and 4 and best in grades 1 and 2. Thus by classifying these growths as to both grade of malignancy and degree of mural penetration a more accurate prognosis can be achieved than by employing either method of classification alone.

In the effort to further individualize the prognosis these same groups that is, those falling in grade 2 and those in class C, were compared for the percentage of 5 year survivals depending on the presence or absence of lymph node involvement (Tables IV and VIII). Involvement of lymph nodes by carcinoma is a factor of definite prognostic importance in both of these groups. Thus, when these 3 factors are considered together in a given group of cases of carcinoma of the colon, a fairly accurate prognosis can be made. However, lest one be led into too gloomy an

TABLE XIII—INVOLVEMENT OF LYMPH NODES AND FIVE YEAR SURVIVALS—CASES SHOWING DEGREE C OF MURAL PENETRATION

Lymph nodes	Total number	Survivors number	Survivors per cent
Not involved	51	30	58.8
Involved	38	14	36.8
Total	89	44	49.4

outlook from such calculations, it is well to mention that of 5 cases of grade 4 malignancy, class C mural penetration and with positive involvement of lymph nodes by carcinoma, 2 are to be found in the group surviving resection for 5 or more years.

### CONCLUSIONS

1. Prognosis is observed to be unfavorably influenced especially by higher degrees of mural penetration of carcinoma cells by higher histological grade of malignancy and by carcinomatous involvement of regional lymph nodes.

2. The 3 aforementioned factors are mutually dependent to a considerable degree in that the deeper the carcinomatous penetration, the greater the probability of lymph node involvement, and the greater the probability that the growth is of a higher histological grade of malignancy. Likewise the higher the histological grade of malignancy the deeper is mural penetration likely to be found and the more likely it is that lymph nodes are involved. Nevertheless these factors operate independently to a certain degree in that for any class of penetration the prognosis is poorer the higher the histological grade of malignancy, similarly for any histological grade of malignancy, the deeper the penetration the worse the prognosis.

3. A more accurate estimation of prognosis in cases of carcinoma of the colon can be achieved by employing the method of classification proposed here together with Broders' histological grading of malignancy than is possible by the use of either method alone.

### REFERENCES

1. BRODERS A. C. Squamous-cell epithelioma of the lip: a study of 537 cases. J. Am. M. Ass. 1920 74: 656-664.
2. Idem. The grading of carcinoma. Minnesota Med. 1925 8: 726-730.

- 3 COLE, P P The intramural spread of rectal carcinoma, with special plate Brit M J, 1913, 1 431-433
- 4 DUKES, C E The classification of cancer of the rectum J Path & Bacteriol, 1932, 35 323-332
- 5 Idem Histological grading of rectal cancer Proc Roy Soc Med, 1937, 30 371-376
- 6 EWING, JAMES Neoplastic Diseases 3rd ed, p 1127 Philadelphia W B Saunders Co, 1928
- 7 GRAY, H K Factors that influence curability of carcinoma of the stomach Proc Staff Meet Mayo Clin, 1932, 7 347-361
- 8 KARSNER, H T, and CLARK, BURTON Analysis of 104 cases of carcinoma of the large intestine Am J Cancer, 1932, 16 933-970
- 9 MACCARTY, W C Factors which influence longevity in cancer, a study of 293 cases Ann Surg, 1922 76 9-12
- 10 MILLER, R T Cancer of the colon Ann Surg, 1923, 78 209-225
- 11 OCHSENHIRT, N C The significance of mucus-forming cells in carcinoma of the large intestine and rectum Surg, Gynec & Obst, 1928, 47 32-35
- 12 RANKIN, F W, and BRODERS, A C Factors influencing prognosis in carcinoma of the rectum Surg, Gynec & Obst, 1928, 46 660-667
- 13 RANKIN, F W, and OLSON, P F The hopeful prognosis in cases of carcinoma of the colon Surg, Gynec & Obst, 1933, 56 366-374
- 14 WELCH, D A On the surgical pathology of the large intestine with special reference to carcinoma Edinburgh M J, 1912, 8 103-110



# THE INFLUENCE OF VITAMIN D UPON BONE REPAIR

## The Healing of Fractures of Rachitic Bones

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THE importance of vitamin D supplements in the repair of bone has been a subject of much controversy during the past 10 years. Opinions expressed by clinicians and results reported from the research laboratories have differed widely. The statement, found in most of the textbooks, that "fractures of rachitic bones heal promptly and with abundant callus" was not supported by our clinical experience except in those instances in which vitamin D was added to the diet of the patient.

Royster states, "Fractures of long bones (in rickets) are common. These are usually of the greenstick variety." Cotton believed that in rickets the common injury is an "infraction." He states, "An infraction is a fracture that differs from a greenstick in that the convex side is bent, the concave side crushed. They occur typically in the fractures of rickets." Foote, in discussing traumatic injuries in rickets, stated, "fractures of the long bones such as the clavicle, radius, ulna, humerus, femur, ribs, and fibula are quite common. These fractures are very frequently of the impacted greenstick type, with little or no displacement and with abundant callus." In a second reference from the same book (8) this author says, "The bones readily unite and form abundant callus and the injury seems less painful than fractures in normal bones."

Our clinical observations indicated that fractures of rachitic bones were not infrequently complete, with displacement and angulation. Union occurred slowly and little callus was formed, although in contrast with the extremely atrophic bone the amount or density of callus might appear to be adequate. The following reports demonstrate the healing of fractures in 2 patients with active rickets.

CASE 1 J. T., female aged 15 months was admitted to the University of Chicago Clinics on January 5, 1934 for the treatment of rickets and deformity of the left femur. Five months before admission she fell out of bed sustaining a fracture of the femur. A cast was worn for only 2 weeks. After removal of the cast an anterolateral angulation developed. She had not walked since the date of the fracture. No vitamin D supplement was administered during this 5 month interval. Physical examination revealed a marked anterolateral bowing of the left leg. The epiphyses of the wrists and ankles were palpably enlarged and roentgenograms showed a fracture of the middle third of the left femur with angulation and minimal callus. The lower end of the femur showed cupping, flaring and irregular ossification indicative of an extremely active rickets (Fig. 1). Calcium of the blood serum was found to be 9.9 milligrams per cent and the inorganic phosphate was 2.1 milligram per cent. This patient was given 10.5 grams of cod liver oil daily in addition to a balanced diet and there was rapid healing of the rickets and of the fracture and the patient became normally active. After 3 months the serum calcium was 10.3 milligrams per cent and the inorganic phosphate was 5.6 milligrams per cent.

CASE 2 C. P. male aged 16 months was admitted to the University of Chicago Clinics on July 10, 1935 for treatment of active rickets and a 2 day old fracture of the femur. Antirachitic therapy consisted of viosterol and cod liver oil and both the fracture and the rickets healed rapidly (Fig. 2).

These cases are typical of those which we have observed in treating fractures of rachitic bones. They indicate that bone repair in the presence of an acute deficiency of vitamin D may be greatly retarded.

Fischer and Key, Hellner, Lewis, Moritsch and Krammer, Pincussen and Neumann, Swart and Vara Lopez have individually studied the effect of vitamin D supplements in the treatment of fractures of supposedly normal bones and have reported no change in the rate or quality of healing. Collazo reported that the addition of vitamin D produced better callus and stronger union than was present in the control animals but that it delayed absorp-

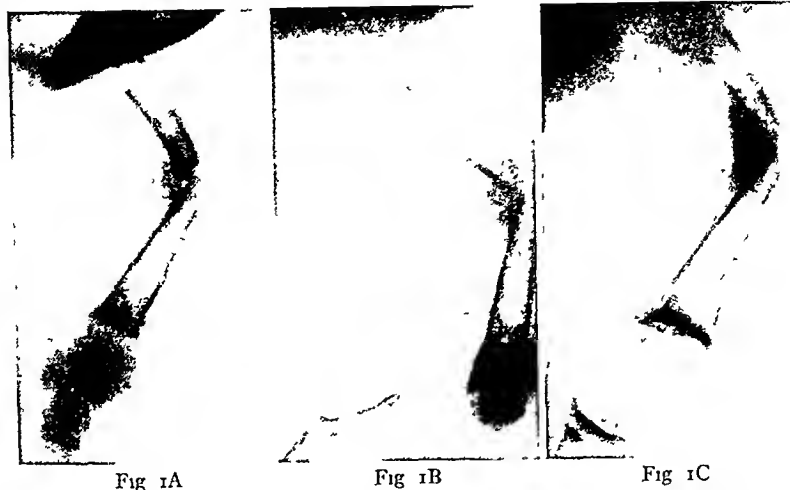


Fig 1 Case 1, J T, female, age 15 months. Five months before admission to the University of Chicago Clinics, at the age of 10 months the patient fell out of bed, sustaining a fracture of the left femur. A cast was applied and worn for 2 weeks. Upon removal of the cast, marked anterior angulation of the femur developed. During the 5 months she had not been willing to try to walk and showed evidence of pain when attempts were made to persuade her to stand. A, Roentgenogram of the left femur, 5 months after fracture, shows changes typical of moderately active rickets. The femur is atrophic with paper-thin cortices and a wide medullary canal. The fracture has united in marked malposition with a minimal amount of callus. From the date of this roentgenogram she was given 10.5 grams of cod liver oil daily, in addition to a well balanced diet. B, Roentgenogram 49 days after beginning cod liver oil therapy. Evidence of better ossification especially in the metaphyseal region indicates the quality of healing of the rickets. There is better healing of the fractured femur. C, This roentgenogram shows complete healing of the rickets and extensive new bone formation on the concave side of the fracture angulation 89 days after beginning the vitamin D supplement. The medullary canal has been restored. The portions of cortex of the femur which are incorporated within the new bone formed at the fracture site are undergoing absorption. It is of interest to note that as more tensile strength develops in the bone which is filling out the angle formed by the malunion of the fragments and there is accordingly less stress on the cortex of the femur on the convex side of the angle, a tendency toward remodeling is under way, as evidenced by the absorption of this lateral cortex. Such a process may be expected to lead to gradual straightening.

Fig 2 Case 2, C P, male, age 16 months. A, Roentgenogram of complete transverse fracture of the midshaft of the femur of an infant with active rickets. The distal end of the femur and the proximal end of the tibia show marked fraying and slight cupping. There is some increase in density in the metaphyseal region of the femur suggesting



beginning healing. Beginning on the third day after the fracture, viosterol (15 drops) was administered twice each day. Three days later, 5 grams of cod liver oil daily were added. B, Four weeks after fracture. A moderate amount of callus has formed and there is further evidence of healing of the rickets. C, After 7 weeks. The rickets has healed and there is complete union of the fracture but the cortices of the fragment ends contained within the callus have not undergone absorption and the medullary canal has not been restored. The apparent defect, a, on the lateral side of the distal end of the femur probably represents a cartilage inclusion. Note the densely ossified, but smooth serrations of the distal end of the femur.

tion of the old fragment cortices. Collazo's reports are confusing in view of the fact that his studies included fractures in both rachitic and normal animals. Tammann was unable

to determine any difference in the rate or quality of fracture healing in animals receiving therapeutic doses of vitamin D, but after 60 days he found that the callus at the site of

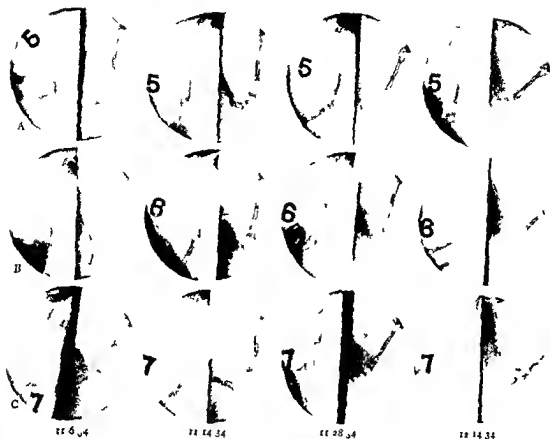


Fig. 3. Experiment 1. Group 1. Compound fractures of the tibia and of the radius of rats Nos. 5, 6, and 7 showing active rickets at the time of fracture, November 6, 1933. The deficiency diet was continued throughout the experiment. As illustrated in roentgenograms taken at intervals

of approximately a week, the rickets remained active and there was little evidence of healing of any of the fractures. The bones of both extremities shown in the roentgenograms show little growth or development and are as atrophic 38 days after fracture as on the day of operation.

the fracture of the animals receiving massive doses of the vitamin supplement began to undergo absorption. He was able to demonstrate in the histological sections median necrosis in the callus. Bors concluded that the callus of the animals treated was the same after 15 days following fracture but was denser 22 days after than that of the controls.

Pappenheimer found that in fractures of rachitic bones the callus remained calcium free unless the animals were given treatment with cod liver oil. Somewhat similar results were also obtained by Urist.

Grauer reported bone absorption when massive doses of vitamin D were given to experimental animals, and Jones and Robson were

also able to demonstrate that irradiated ergosterol in toxic doses produced marked degenerative changes in the growing bones of rats. Their microscopic studies showed that the atrophy resulted from the removal of organic as well as inorganic matrix. The bones were soft and fragile.

One of the authors (Compere) together with Gorman in a recently published report in which the healing of fractures of atrophic bones was the subject of an experimental study, suggested that there is a threshold of mineral and vitamin normalcy below which bones become atrophic or rachitic, but that addition of minerals or vitamins to the well balanced diet was not therapeutically sound.

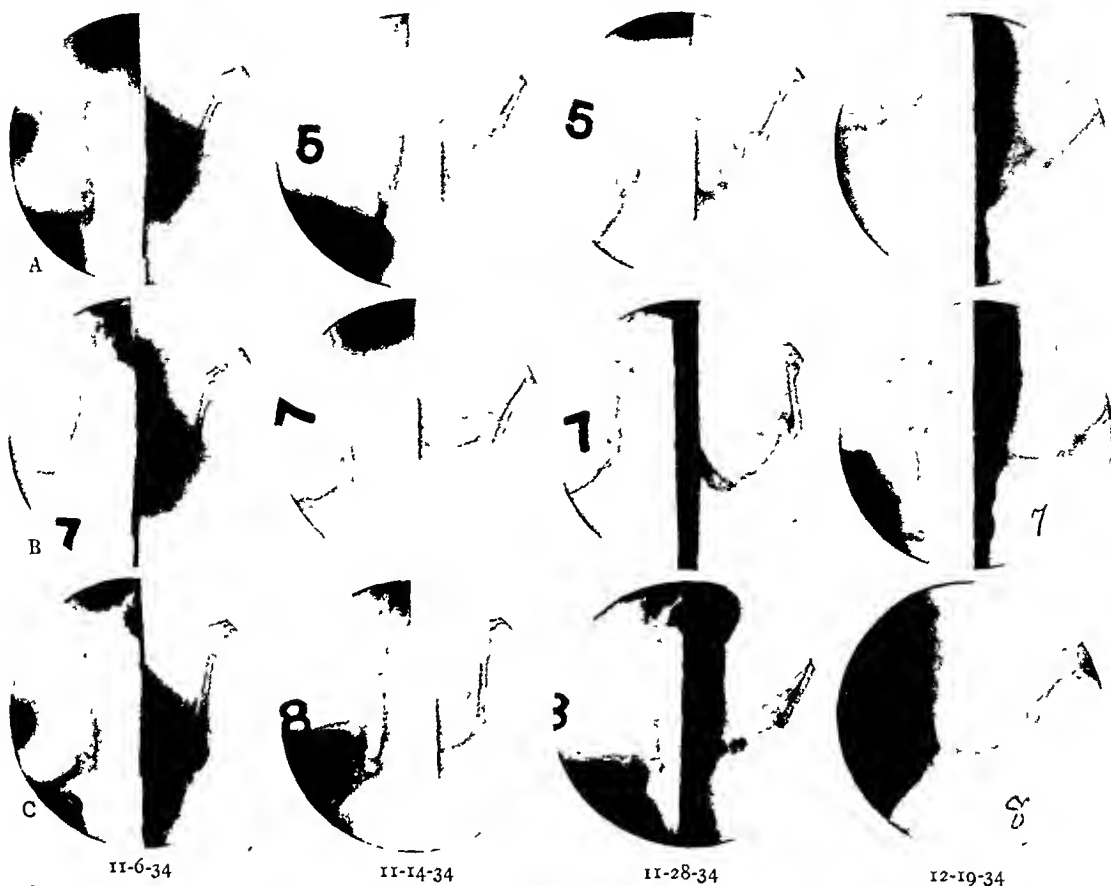


Fig 4 Experiment 1, Group 2 Compound fracture of the radius and tibia of 3 of the rats in this group Active rickets at the time of operation November 6, 1934 Cod liver oil was added to the diet on the day following operation and 43 days later, December 19, 1934, the roentgenograms show marked improvement in quality of the bone,

in healing of the rickets, and union of the fractures of rats Nos 5 and 8 Callus has formed about the fracture of rat No 7 but refracture occurred A line of decreased density across the site of the fracture shown in the roentgenogram which was taken December 19, 1934 suggests pseudarthrosis

With the exception of the report of Pappenheimer and the unpublished work of Urist, the importance of vitamin D in the repair of bones of animals kept for long periods of time on a vitamin D deficiency diet has not been made the subject of an experimental study

Because of the apparent confusion with regard to the importance of vitamin D supplements in bone repair, the experiments reviewed in this report were undertaken. In the furtherance of this study the department of pediatrics and the division of orthopedic surgery collaborated

The rat was selected as the experimental animal, both because of the ease with which

rickets can be produced and because of the relatively short time required for growth to skeletal maturity Each of 3 experiments was carried out with groups of 21 day old rats, of standard stock The rickets-producing McCollum Diet, No 3143, was used This diet is high in calcium, low in phosphorus and quite deficient in vitamin D Its components are: 33 parts ground whole yellow corn, 33 parts ground wheat, 15 parts gluten, 15 parts gelatin; 3 parts calcium carbonate, and 1 part sodium chloride.

The normal stock diet used had the following composition 150 parts ground whole yellow corn, 67 parts whole milk powder, 32

TABLE 1 — EXPERIMENT I COMPOUND FRACTURES OF TIBIA AND RADIUS ANALYSES OF POOLED BLOOD OF EACH GROUP OF RATS SURVIVING 44 DAYS AFTER FRACTURE\*

Group	No. of rats	Algen phosphorus per 100 ccm serum	Results
1 Rickets producing diet + vitamin D	8	2.2	No union, faint callus, atrophied bone alight blue of rickets
2 Cod liver oil added to rickets prod. diet after fracture	8	5.1	Moderate callus union in 7 rats pseudo throm. in 1 rickets healed
3 Rachitic diet plus cod liver oil from start of the experiment	8	5.1	Moderate callus no rickets
4 Stock diet	7	7.8	Slight union, large bone all at medullary canal rest red

The results shown in Table I at demonstrated more graphically in Chart 1. They indicate a correlation between the inorganic phosphorus content of the blood serum and the rate and degree of healing of the fractures.

In each of the 3 experiments the blood was drawn by heart puncture under light ether anesthesia.

parts linseed oil meal, 10 parts casein, 4 parts alfalfa meal, 4 parts yeast, 1 part calcium carbonate, and 1 part sodium chloride. Vitamin D supplements of 2.5 per cent of cod liver oil were added to the rachitic diet of Group 2 immediately after fracture and to that of Group 3 at the beginning of the experiment 3 weeks before fracture.

#### EXPERIMENT I COMPOUND FRACTURE OF TIBIA AND RADIUS

Thirty-one rats 21 days of age were used in this experiment. They were placed on special diets for 21 days before fracture, as follows:

Group 1 Eight rats were fed rachitic diet No 3143.

Group 2 Eight rats were fed the same diet as Group 1 (Cod liver oil added after fracture).

Group 3 Eight rats were fed rachitic diet with cod liver oil supplement.

Group 4 Seven rats placed on normal stock diet.

At the end of 21 days on these various diets one tibia and one radius were exposed under ether anesthesia. The bones were divided with heavy scissors and the wound was closed. No splint was used. To the rachitic diet of Group 2 cod liver oil was added from the day of this operation. Roentgenograms were made at intervals of 1 week. One half of the animals used in this experiment were killed at the end

#### PROTOCOL OF EXPERIMENT I RESULTS OF X RAY EXAMINATIONS\*

Date	Group 1**	Group 2	Group 3	Group 4
11-6-31	Active rickets	Cod liver oil added to diet all showed active rickets	No rickets rat died	Large rat a broken bone than in any of other groups
11-24-31	No callus	Faint callus brown rickets healing	No union no definite callus	All showed callus and beginning union
12-1-31	No callus	Union complete in 4 with good callus callus adequate in 3 but had fracture in 1 at No. 6 there was pseudoarthrosis in 1 as well as healed in all	Beginning union in all moderate callus	Fracture of 7 showed bony union in 2 showed good callus but had refractured
12-25-31	No bone union	Seven showed union in 2 the 7 had pseudoarthrosis	All good except union	All showed at beginning union
1-6-32	No bone union callus	Rat No. 7 showed pseudoarthrosis No. 6 was doubtful	Only Nos. 1 & 2 showed union maintained both they were well unioned	All showed good bony union
1-14-32	Faint union but very little callus	Nos. 1 and 2 excellent union with reopening of medullary canal	Solid bony union of both tibia and radius	All showed good bony union
2-10-32	43 days after fracture all light spontaneous healing of rickets a complete union Surviving rats sacrificed	All unioned except No. 7	Excellent bony repair all	Excellent repair bony union of tibia and radius all

\*Diets of all groups were begun on October 1, 1931; date of peritonitis for all 4 groups was 1-3-32.

\*\*Eight rats were used in all groups except Group 4 in which there were 7. Nos. 1, 2, 3 and 4 of all groups were sacrificed November 25, 1931.

of 3 weeks. The remaining animals were bled under light ether anesthesia and sacrificed 6 weeks following the fracture, when they were 63 days old.

Because of the small number of rats in each group insufficient serum was obtained to determine both phosphorus and calcium so that only inorganic phosphate determinations were made. The results of this study are shown briefly in Table I and more graphically in Chart 1.

Most of the rats that were fed the stock diet were able to use the fractured extremities

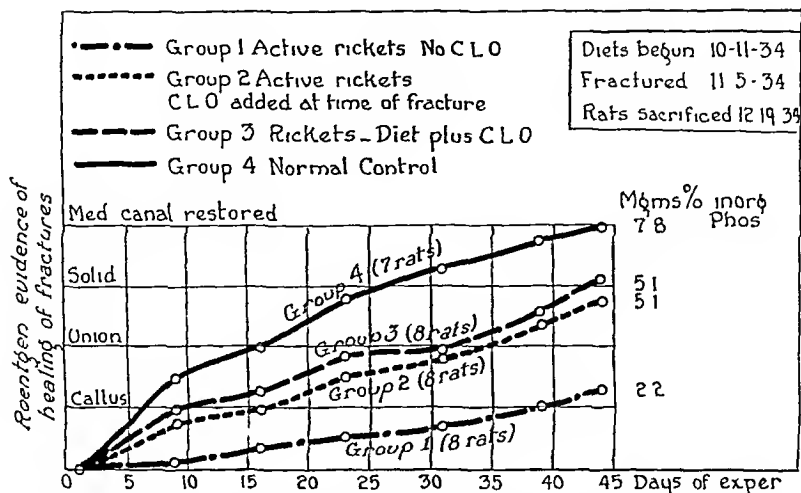


Chart 1 Experiment 1, rate of union of compound fractures of tibia (rats) For the preparation of this chart an attempt was made to compare the degree of fracture healing shown in roentgenograms, taken at approximately weekly intervals, from the time of fracture. The healing of the fracture occurred most rapidly and the fractured bone was restored to a more nearly normal roentgenographic appearance in the rats of the group receiving the normal stock diet. From a roentgenographic standpoint there was very little evidence of healing of the fractures in the group of rats with active rickets. Addition of cod liver oil to the rickets-producing diet, either at the time of fracture (Group 2) or at the beginning of the dietary portion of the experiment (Group 3) resulted in very definite improvement in the rate and degree of fracture healing, but none of the rats in these 2 groups developed as large bones and the fractures did not heal as rapidly nor as completely as did those receiving the stock diet without any vitamin supplement (Group 4). A direct correlation is shown between the inorganic phosphate content of the blood serum of the rats sacrificed 44 days after fracture and the extent of healing as shown in the roentgenograms.

within 2 weeks after fracture, and by the time the experiment ended it was not possible to tell that they had ever been fractured in so far as function was concerned. The rats in all of the 3 other groups were slower to recover use of the fractured extremities. In the group that was constantly fed the rickets-producing diet, some of the rats were never able to use the injured limb. The rats fed the normal diet were more than twice as large and were much more active than were those in the 3 other groups. In this experiment, as well as those to follow, the inorganic phosphorus was determined by the method of Fiske and Subbarow and the calcium was determined by the method of Fiske and Logan, with a slight modification.

Acute vitamin D deficiency, which produced rickets in rats, appeared to be a definite factor in causing delayed union and non-union of compound fractures of both the radius and tibia. The compound fractures were not in-

fectured and the wounds through which the bones were exposed, healed by primary intention. Additions of vitamin D to the deficiency diet either prevented or cured rickets. The addition of this supplement, however, did not raise the quality of the diet to that of the stock diet, as evidenced by the fact that the rats in Group 4 developed more rapidly and their fractures healed more promptly than did those of any other group.

#### EXPERIMENT 2: SIMPLE FRACTURES OF THE TIBIA

The rats were divided into 3 groups. Group 3, which in Experiment 1 had received cod liver oil in addition to the rickets-producing diet from the time of beginning the experiment, was omitted.

Three weeks after beginning the special diets, one tibia of each rat was fractured at about the level of the middle and upper thirds. No splints were used. With the exception of





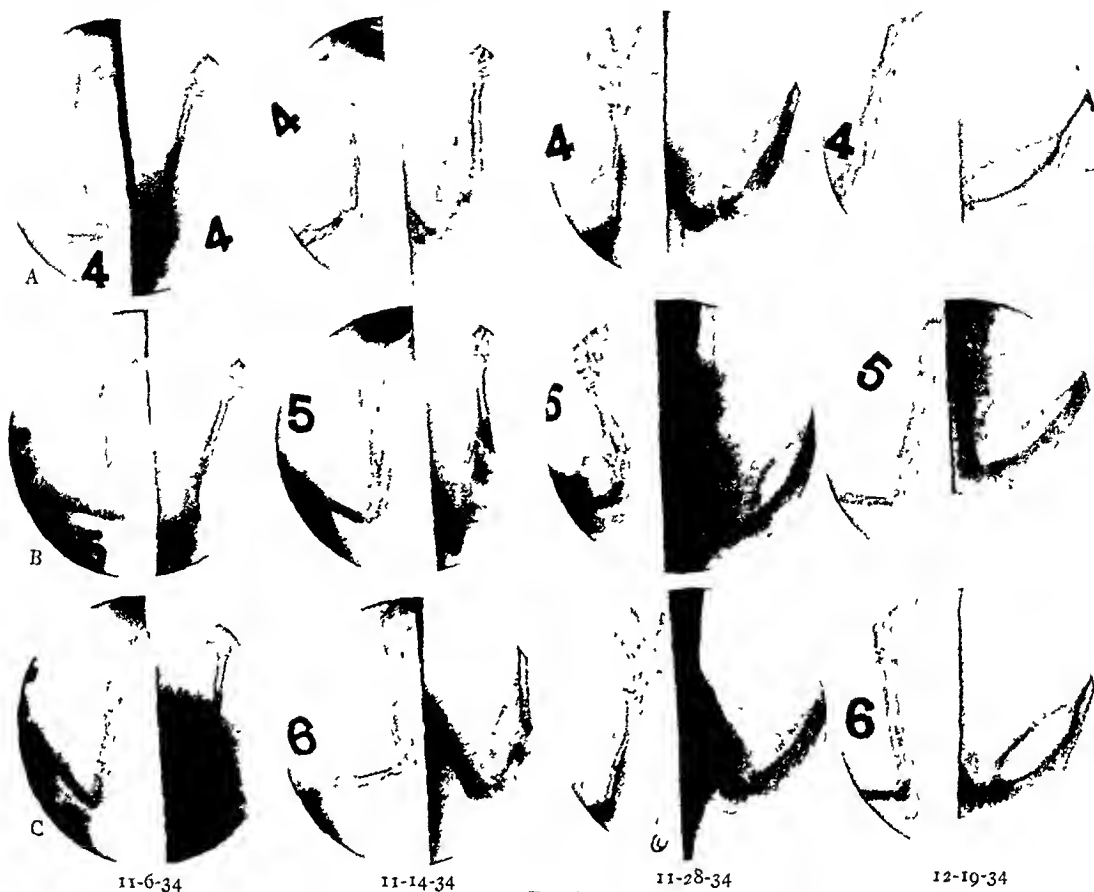


Fig 6

Fig 6 Experiment 1, Group 4 Stock diet The rats in this group were larger and the bones were better developed than were those of any of the preceding groups The compound fracture of the radius and tibia of each rat was made November 6, 1934 Within 22 days, functional union had occurred at the site of each fracture At the end of 34 days the medullary canals at the fracture levels had been re-established The rate and quality of healing of fractures in this group on the normal stock diet, without the addition of a vitamin D supplement, was definitely better than in any of the groups in which a mineral-vitamin D deficiency diet had been maintained, either separately or in combination with cod liver oil

Fig 7 Experiment 2, Group 4, Rat No 1 Normal stock diet Photomicrograph of tibia of rat in the control group of the second experiment This shows strong bone union with the abundant callus completely ossified

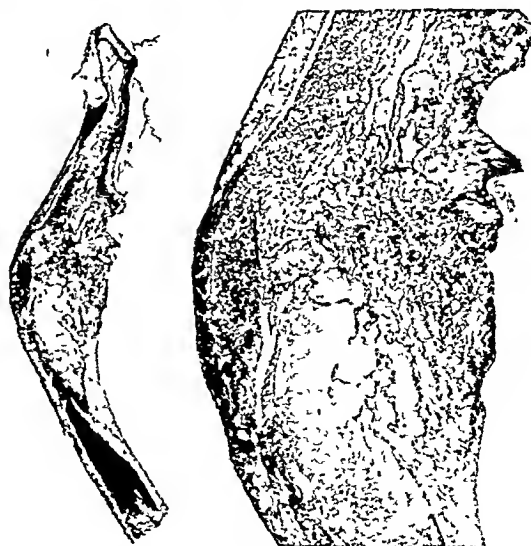


Fig 7

those in Group 1, these rats were using the fractured leg within 2 to 3 weeks after fracture Within 4 to 6 weeks, function of this extremity appeared to be entirely normal Some of the rachitic rats did not recover use of the fractured extremity Toward the end

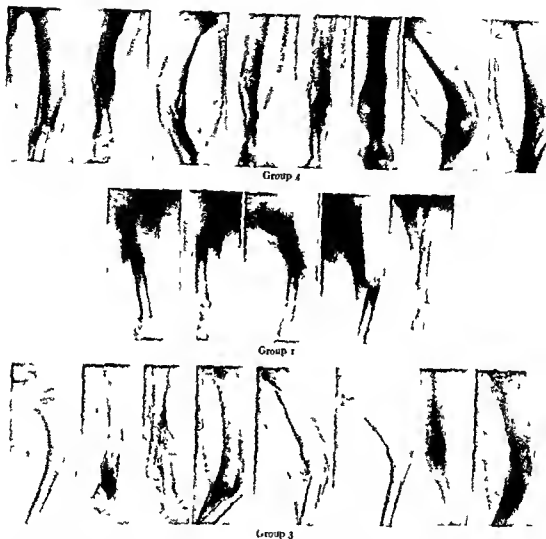


Fig. 8 Experiment 3. Roentgenograms made 43 days after fracture of the tibia of all of the surviving rats in Groups 4, 1, and 3. These roentgenograms show that the development of the bones and the rate and degree of healing of the fractured tibiae of the rats of Group 4 which were fed

a normal stock diet and the rats of Group 3 which received the rachitic diet with the cod liver oil supplement are more advanced than are those of the rats which were kept constantly on the deficiency diet (Group 1).

of the experiment the rats fed the normal stock diet were nearly twice as large as were those of any other group. All of the rats were sacrificed 6 weeks after fracture. The pooled blood from each group was analyzed for inorganic phosphorus and calcium. The fractured bones were removed, roentgenographed, fixed in celloidin, and microscopic sections were prepared. The results were quite similar to those obtained with the compound fractures. No

definite bone union occurred in the rats with active rickets. The rickets in the rats of Group 1 continued active throughout the experiment. At the termination of the experiment inorganic phosphorus of the rachitic group was not as low as it had been in the same group in Experiment 1.

In Group 2, in which cod liver oil was added to the rickets producing diet at the time of fracture and continued until the end of the

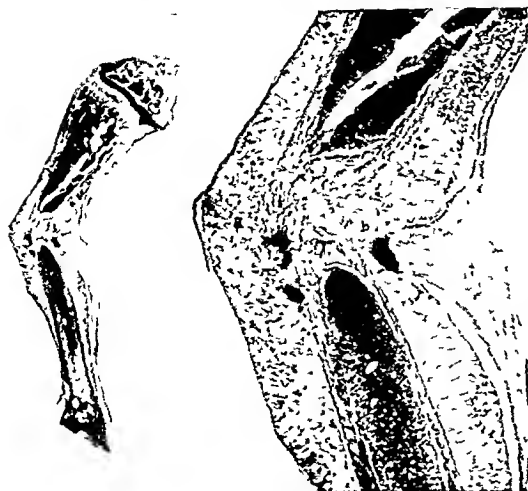


Fig 9

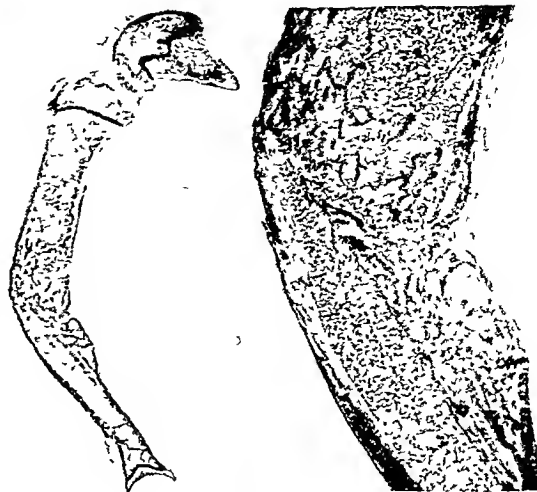


Fig 10

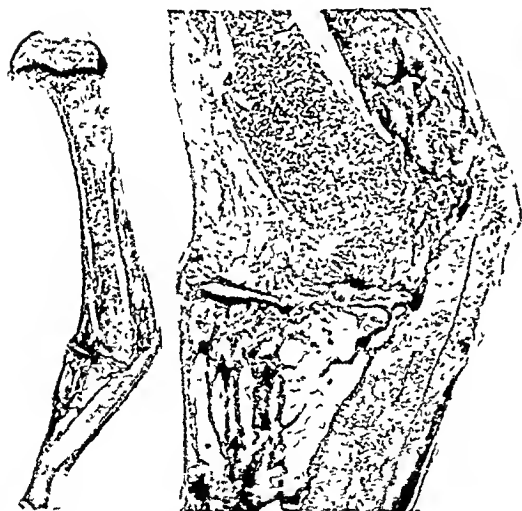


Fig 11

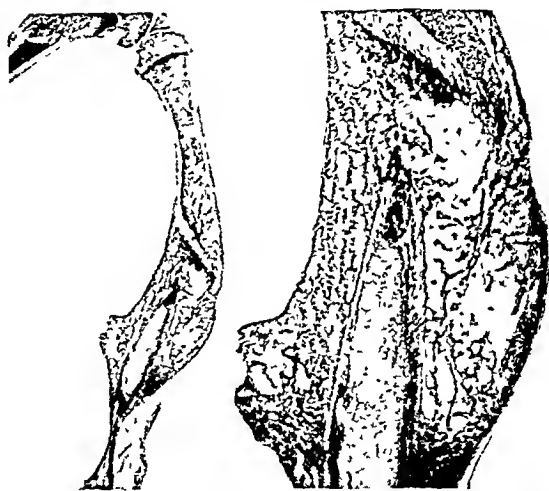


Fig 12

Fig 9 Experiment 3, Group 1, Rat No 3 Active rickets 43 days after fracture. Photomicrographs (low and high power) showing active rickets. There is angulation at the site of fracture. Note the feeble attempt toward osteoplastic union between the ends of the fracture fragments, the poorly calcified, but moderately abundant subperiosteal fibrous, *a*, and cartilaginous, *b*, callus, and the partial absorption of the thin cortices of the fracture fragments contained within the callus.

Fig 10 Experiment 3, Group 2, Rat No 1 Active rickets when fractured, then cod liver oil added. Photomicrograph 43 days after fracture. The rickets is healed. The fracture has united and the callus is moderately well ossified. A small area of fibrous tissue, *a*, is still contained within the fracture site.

Fig 11 Experiment 3, Group 3, Rat No 1 The cod liver oil supplement was added to the rickets producing

diet 3 weeks before fracture and continued throughout the experiment. Rickets did not develop. The tibia of this animal is smaller and the cortices are thinner than those of the rats on the control stock diet. The fracture has healed, but in the line of fracture there is a transverse zone of decreased density representing an incomplete pseudarthrosis partially filled by fibrous tissue. Cortices of the fracture fragments have been extensively absorbed but the medullary canals of the 2 fragments are still separated by a thin zone of cortical bone.

Fig 12 Experiment 3, Group 4, Rat No 3 Normal stock diet. No rickets. Photomicrograph 43 days after fracture. The tibia is larger and the cortices are thicker than are those of other groups. There has been complete osseous union at the site of fracture with re-establishment of most of the medullary canal. Absorption of the cortices of the fracture fragments is still incomplete.

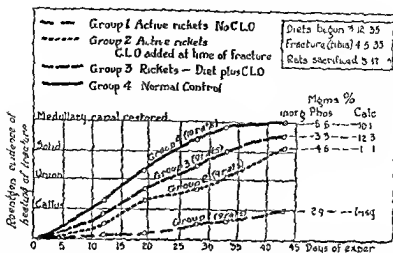


Chart 2 Experiment 3 rate of union of simple fractures of tibia (rats). This chart, prepared from study of the roentgenograms and the blood chemistry determinations of the rats used in Experiment 3, duplicates the findings charted for Experiment 1 in which the fractures were of 2 bones and were compounded. The inorganic phosphate factor is seen to be of greater significance than the percentage of calcium as far as the rate or degree of fracture healing is concerned.

experiment all of the fractures united and the animals were using the extremities normally at the time they were sacrificed. The bones of the rats in Group 2 were larger and better formed than those of Group 1. The fractures

in the group fed the normal stock diet united within 2 to 3 weeks; the bones were large and the medullary canals had been restored.

We were reasonably convinced from Experiment 2 that a well balanced stock diet led to

TABLE III—EXPERIMENT 3 SIMPLE FRACTURES OF ONE TIBIA ANALYSES OF POOLED BLOOD OF THE RATS OF EACH GROUP 43 DAYS AFTER FRACTURE

Group	% Calc	Mgm phosphorus per 100 cc serum	Mgm calcium per 100 cc serum	Remarks
1 Rickets producing diet throughout experiment	5	3.9	1.9	Active rickets, poor union but faint callus
2 Cod liver oil added to diet producing diet after fracture	9	4.6	2.2	Large bone all united
3 Cod liver oil plus rickets producing diet throughout experiment	9	3.3	5.5	Quiescent, large callus, excellent Group 2
4 No malnutrition	1	6.6	10.5	Excellent union, small bone, no serious deformity, no callus, no deformity

\*Some of the rats in this group had died. The few survivors were from the calcium deficient ration.

PROTOCOL OF EXPERIMENT 3 RESULTS OF X-RAY EXAMINATIONS\*

Date	Group 1**	Group 2	Group 3	Group 4
4-6-35	Active rickets	Active rickets	No rickets but bones were smaller than those of Group 4	No rickets well developed bones
4-17-35	No union and callus	Faint callus rickets healing	Small amount of callus	All showed abundant callus
4-24-35	No union	Rick is healed, all showed good callus	Medial callus but not united	All union good solidating
5-3-35	No union	All rats showed bone union	All united	Excellent union with no deformity
5-6-35	Faint callus all down in 3 weeks no union	Excellent union	Excellent union	All well union
5-17-35	Faint callus on 1 ricket still active	Bones larger than those in Group 1	Medial rickets all healed	Medial rickets all healed

\*Diets in all 4 groups were begun on March 12, 1935. Diet 1 (rickets) was continued until May 3, 1935.

\*\*The diet was to be used in each group except Group 4 which had a normal diet.

(There is 1 rat in Group 2 died between May 3, 1935 and May 8, 1935)

the development of healthier, stronger bones which healed more rapidly following fracture, and the quality of union was much better than in the bones that were atrophic because of subacute vitamin D deficiency as noted in Group 3 of Experiment 1, or in the case of active rickets. We decided to attempt to confirm or to correct this impression by repeating Experiment 2 and including Group 3.

#### EXPERIMENT 3. SIMPLE FRACTURES OF TIBIA

The plan of Experiment 3 was identical with that of Experiment 2, with the exception that Group 3, which included the rats fed the rachitic diet plus cod liver oil for 3 weeks before fracture and continued after fracture until they were sacrificed, was included. These rats were sacrificed 43 days after fracture and the pooled blood from each group was analyzed for its calcium and phosphorus content. The results of this experiment are shown in Table III and more graphically in Chart 2.

The results of the analyses of the blood serum pooled from the rats of each of the 4 groups in Experiment 3 show findings quite similar to those of Experiments 1 and 2.

The photomicrographic sections show better development of the bones and better healing of the fractures of the rats fed a normal stock diet than could be demonstrated in any other group (Fig 7). There was no osseous union of the fractures in the group that still had active rickets. Healing of the fractures, the quality of bone, and the restoration of function seemed to be in direct proportion to the maintenance or re-establishment of the normal content of inorganic phosphorus in the blood serum.

#### DISCUSSION

The histology of healing fractures in rats fed diets low in total salt, calcium, and phosphorus, and in rats fed normal diets, has been described in detail by Downs and McKeown. Using a similar technique, Goisman and Compere were able to demonstrate that the healing of fractures of atrophic bones produced by a diet low in calcium progressed to a stage of complete bony union at a rate comparable to that observed in animals fed a normal stock diet. The total amount of bone laid down in

repair was less and the new trabeculae and cortices of the bone were definitely thinner in those animals fed the deficient diet than in those constantly receiving a diet adequate in calcium. In some instances union of the atrophic bones occurred more quickly although the quality of the union was never better than the quality of the bone which had been fractured.

In the study which is presented here, it would seem quite definite that fractures of bone affected by active rickets heal poorly. Fibrous union occurred, but calcification was delayed in each instance by active rickets. Non-osseous union and pseudarthrosis were found in the majority of the fractures of rachitic bones after the rats were sacrificed. As demonstrated from observation of rats, from the roentgenograms, the blood chemistry determinations, and photomicrographic sections, *the animals which were kept on a normal stock diet throughout, without additional supplement of vitamin D, developed more rapidly, were definitely larger, had longer and larger bones, and the fractures healed more promptly than did the treated or untreated rachitic rats.* Normal function was restored in from 2 to 3 weeks with complete bony union of the fractures and restoration of the medullary canals both in the compound and in the simple fractures. The rats which were fed the rickets-producing diet until the time of fracture and then were treated by adding cod liver oil as a supplement until they were sacrificed, showed healing of the rickets and of the fractures.

The results obtained in the rats of Group 3 which were fed the vitamin D supplement in addition to the rickets-producing diet from the time of the beginning of the experiment were similar to those of Group 2, which had the vitamin D supplement added at the time of the fracture. In neither of the 2 groups did the rats grow as large, the bones as long, the cortices as thick, nor the diameter of the shafts as wide as did the rats fed the unre-enforced stock diet, and fractures were definitely slower in healing.

In the previously reported study of Goisman and Compere, it was shown that the administration of an excess of vitamin D or calcium carbonate or both of these elements to the diet of rats previously fed a diet low in calcium or a

normal stock diet, did not hasten the rate or the quality of the healing of fractures. Grauer, and Jones and Robson have demonstrated degenerative changes in the bones and retardation healing of fractures as a result of the feeding of excessive or toxic doses of vitamin D.

Our studies indicate the importance of including in the diet sufficient vitamin D to supply the basal requirement for the growth or repair of bones of growing animals. We may postulate a need of vitamin D supplement for adults whose diet may have been deficient in mineral or vitamin content producing osteoporosis or osteomalacia. Where either type of skeletal change is demonstrated we may be justified in prescribing vitamin D in therapeutic amounts. It would seem reasonable to assume that such therapy would be of value in the treatment of fractures in these types of cases. Knoflach has reported that vitamin D added to the diet of patients over 55 years of age aided greatly in fracture healing but he was not able to see any benefit from the vitamin D supplement in younger patients. If true, these observations would seem to indicate that chronic vitamin D deficiency (subclinical) is common among elderly patients.

Within the past few years many clinicians have been prescribing enormous doses of vitamin D in the form of purified concentrates. Some of them have advocated both the addition of vitamin D and calcium to the diet of patients who had sustained fractures. Unless these patients are suffering from chronic or acute vitamin D deficiency it is possible that such excessive amounts of vitamin D concentrates may cause non union or delayed union. Since prolonged use of such large doses of vitamin D may not only delay healing of fractures but produce degenerative changes in the bones of experimental animals.

#### CONCLUSIONS

1. Acute vitamin D deficiency in growing rats if continued long enough to produce active rickets, may cause delayed or non union of fractures.

2. The addition of vitamin D in therapeutic doses to the rickets producing diet was found to prevent or to heal the rickets and to bring

about more rapid and a better quality of healing of fractures of the bones of rats.

3. Bone growth and development was definitely retarded in the rats kept constantly on the vitamin D and phosphorus deficiency diet. In each of the experiments the rats in this group were smaller, the bones shorter and more fragile than were those of the other 3 groups.

4. Rats receiving no vitamin D supplement but kept consistently on the well balanced stock diet developed more rapidly, and at the termination of the experiment were twice as large as those in the other 3 groups. The bones were proportionately larger and stronger and fractures in the bones of the rats in this group healed more rapidly, function was restored more promptly, and at the end of the experiment it was difficult to observe any defect in the appearance or the function of the extremity in which the fracture had occurred.

#### BIBLIOGRAPHY

1. Boes E. Vitaminol und Frakturheilung. Zentralbl f Chir 1927 54 3766.
2. Collazo J A, Felsky P and Varela B. Die Rolle des Vitamins D fuer die Regeneration des Knochengerueses und die Callusbildung bei experimentellen Frakturen. Arch f Klin Chir 1930 158 214.
3. Corro F J. Dislocations and joint fractures. 2nd ed. p 23. Philadelphia and London: W B Saunders Company 1924.
4. Down W G Jr and McKewen R M. Histology of healing fractures in rats on diets low in total salt calcium and phosphorus. Arch Surg 1932 25 109. Histology of healing fractures in rats on normal diets. Ibid 1932 25 94.
5. Fischer J and Key J A. Local atrophy of bone: all effects of vitamin D and of calcium on local atrophy and union. Arch Surg 1934 20 31.
6. Isaak C H and Logan M A. The determination of calcium by alkalimetric titration. J Biol Chem 1931 93 221.
7. Fischer C H and Subbarow Y. Colorimetric determination of phosphorus. J Biol Chem 1932 60 375 400.
8. Foote J A. Disease of the bones, joints, muscles and tendons. Clinical Pediatrics vol 1, p 176 193. New York and London: D Appleton and Company 1927.
9. Costran J and Compere E I. The healing of fractures of atrophic bones. J Bone & Joint Surg 1938 20 587.
10. Grauer R C. The effect of viosterol on the peroneum in experimental fractures. Arch Surg 1932 25 1035.
11. Hellner H. Der Einfluss des Vitaminols auf den Frakturcallus beim gunden Versuchstier. Deutsche Zeitsch f Chir 1928 209 307.
12. Jones J H and Robson G M. The effect of over doses of irradiated ergosterol administered for

- 2 months, on composition and structure of bones of rats *Am J Physiol*, 1933, 103 338
- 13 KNOFLACH, I G Behandlung der Knochenbrueche mit bestrahltem Ergosterin *Wien klin Wchnschr*, 1928, 41 739
- 14 LEWIS, K M Non-effect of irradiated ergosterol in treatment of fractures *Ann Surg*, 1930, 92 415
- 15 MCCOLLUM, E V, SIMMONDS, N, SHIPLEY, P G, and PARK, E A Studies on experimental rickets VIII The production of rickets by diets low in phosphorus and fat-soluble *Am J Biol Chem*, 1921, 47 507
- 16 MORITSCH, P, and KRAMMLER, E Ueber den Einfluss eines Kalk-und phosphorhaltigen Vitaminpraeparates (Vitophos) auf die Callusbildung *Wien med Wchnschr*, 1929, 70 1454
- 17 PAPPENHEIMER, ALVIN M Experimental rickets in rats VI The anatomical changes which accompany healing of experimental rat rickets, under the influence of cod liver oil or its active derivatives *J Exper Med*, 1922, 36 335
- 18 PINCUSSEN, L, and NEUMANN, B Ueber Beziehungen der Knochenbruchheilung zu chemischen Veraenderungen im Blute und ihre Beeinflussung durch Calcium-Vitaminbehandlung *Arch f klin Chir*, 1931, 195 483
- 19 ROEGHOLT, M N Der Einfluss der A-, B-, C-, D Vitamine und der Elemente Ca und P auf die Heilung von Knochenbruechern *Arch f klin Chir*, 1932, 168 783
- 20 ROYSTER, L T Nutrition and development *Clinical Pediatrics*, vol 10, p 234 New York and London: D Appleton and Company, 1927
- 21 SWART, H A The effect of irradiated ergosterol on the healing of experimentally produced fractures in animals *J Bone & Joint Surg*, 1930, 12 360
- 22 TAMMANN, H Ueber die Vitasterinschaedigung der Frakturheilung *Arch f klin Chir*, 1931, 165 473
- 23 URIST, M R, and McLEAN, F C Calcification studies in the healing of experimental fractures A dissertation submitted to the Faculty of the Division of the Biological Sciences in Candidacy for the Degree of Master of Science, Department of Physiology, University of Chicago Unpublished
- 24 VARA-LOPEZ, R Experimentelle Untersuchung Ueber die Beeinflussung der Frakturheilung durch Vigantol *Deutsche Ztschr f Chir*, 1928, 212 101-105



# STUDIES OF THE ANALEPTICS I CORAMINE

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**I**N a previous paper (4) dealing with the acute safety of ether, divinyl ether, and chloroform, we emphasized the fact that *an anesthetic death should be regarded as a failure of resuscitation*. The studies of resuscitation from respiratory arrest produced by these drugs showed that *prompt artificial respiration combined with the administration of oxygen is highly efficient*. In practice, these measures are usually supplemented by one of the analeptics. We are attempting in this series of studies to determine the value of certain of these drugs for this purpose.

Among the analeptics, one of the most commonly employed is pyridine beta carboxylic acid diethylamide, studied extensively by Uhlmann in 1924 and popularly known as "coramine." This substance is reputed to have an "awakening action" in various types of narcosis and to stimulate the severely depressed respiratory center. Although numerous experiments have been conducted to determine its value in barbiturate and avertin narcosis, there have been few controlled studies dealing with its antidotal action against the inhalation anesthetics.

The experiments reported in this paper deal with the effect of coramine upon the minimal dose of ether and of chloroform required to produce respiratory arrest in dogs and with its influence upon the probability of resuscitation from a rapidly administered overdose of these agents.

## THE EVALUATION OF AN ANALEPTIC

The satisfactory clinical determination of the value of an analeptic presents two serious difficulties which arise from the necessary absence of control experiments. In the first place, the physician can never be quite sure that the dose of the depressant acting would be certainly fatal in the absence of treatment. Secondly, he is not free to use his patient >

condition as an opportunity for an experimental study of a drug but must do every thing in his power to aid recovery. Acceptable evidence of the value of an analeptic is almost impossible to obtain under these handicaps.

The laboratory worker has the great advantage of being able to administer deliberately a measured fatal dose of a depressant to his experimental animal under a standardized set of conditions. He is thus enabled to assay the antidotal efficiency of an analeptic agent against doses of the depressant known to be fatal. This type of data can be obtained only in the experimental laboratory.

As the following brief analysis shows the antidotal action of coramine varies with (1) the physiological conditions existing at the moment, (2) the depth of the narcosis, (3) the particular depressant against which it is employed, and (4) the dose of the drug.

**1 Physiological conditions at the moment**  
The response of the cells of the respiratory center to a stimulant is an expression of their specialized function. Here, as elsewhere in the body, anoxemia injures the specialized function first. Consequently, as asphyxia becomes more acute the vigor of the center's response to stimulation progressively diminishes with the result that the best of the analeptics become unreliable just when their action is needed most.

Not only do the respiratory stimulants lose most of their potency in the extremity of asphyxia but, occasionally, after producing a brief and ineffectual action they actually appear to hasten cessation of breathing. Not infrequently, we have seen this "therapeutic paradox" develop during the course of our experiments, and it is our observation that such animals are usually difficult to resuscitate.

The explanation for this phenomenon is probably as follows. Intensification of the activity of the respiratory neurons necessarily increases their rate of oxygen consumption

If this increased activity fails to improve their oxygen supply immediately, acute anoxemia and death of the center will quickly follow. Whether or not, therefore, the injection of an analeptic will precipitate failure of breathing by this mechanism depends upon the ability of the stimulated respiratory and circulatory functions to increase the oxygen supply to the medulla without delay. For this reason, when an analeptic is injected in the treatment of asphyxia, particular care should be taken to maintain a free airway and to enrich the oxygen content of the inspired air.

If our understanding of the physiology of this condition is correct, oxygen is the best and probably the only safe respiratory stimulant for use when asphyxial death is imminent.

2 *Depth of narcosis* The first comprehensive investigation dealing with the antagonism of coramine to the narcotics was carried out by Kohlhoff (1928). He found that coramine (50 milligrams per kilogram intravenously) interrupted a moderate paraldehyde narcosis in rabbits for a period of about 10 minutes. An increase of this dose, or, the administration of a series of injections within a short time, did not strengthen this effect. In deep narcosis the response to even large doses of coramine was very slight. Killian reported that coramine overcame the light narcosis produced in rabbits by a dose of 150 to 200 milligrams per kilogram of avertin. Barlow, on the basis of a very large series of experiments, concluded that coramine will not overcome the deep narcosis produced in rabbits by 300 milligrams per kilogram of avertin. A similar difference between the antidotal action of coramine against light and deep narcosis was observed by Guns. This worker obtained stimulation of respiration during very light chloroform narcosis only. In the presence of deep chloroform narcosis it produced either no effect or was actually a depressant to the respiration. In rats Wagner found that coramine had an awakening effect in light chloral hydrate narcosis but when used against a deep narcosis the duration of sleep was prolonged. Similar results are reported by Zipf, Windschus and Kokoschka.

We may conclude, therefore, that the antidotal action of coramine is experimentally

demonstrable against only the lighter levels of narcosis. An antagonism against the deeper levels of narcosis has not been satisfactorily shown. There is even considerable evidence that under these circumstances coramine may act as a synergist to the depressant.

3 *Nature of the depressant* Kohlhoff found coramine somewhat more antidotal to paraldehyde than to chloral hydrate. According to Maloney and Tatum, coramine is more or less capable of stimulating the respiratory center depressed by urethane, chloral hydrate, avertin, and ether but is ineffective against barbiturate depression. Completely negative results were obtained by Axmacher against barbital narcosis in rabbits. Moritsch found that 40 milligrams per kilogram of coramine intravenously definitely deepened barbital narcosis in rabbits. On the other hand, Lendle obtained marked stimulation of the respiration depressed by morphine. When pernocton or avertin was used he found that coramine prolonged the narcosis.

It is evident from the experiments cited that the antidotal efficiency of coramine probably varies with the depressant.

4 *Dose of coramine* Eichler and Klein found that 100 milligrams per kilogram of coramine intravenously improved the depressed respiration produced in rabbits by 200 milligrams per kilogram of avertin but when a higher dose of coramine was used (above 120 milligrams per kilogram) the respiratory depression was intensified. Maloney employed coramine against the depression produced in rats by 200 milligrams per kilogram of barbital. This dose of barbital is only two-thirds the minimum lethal dose for rats and of itself produced no fatalities in the untreated controls. Doses up to 150 milligrams per kilogram of coramine had no demonstrable antidotal action. When the depression was treated by 200 milligrams per kilogram, the animals were aroused for an average of 1 hour but subsequently became renarcotized and, as compared with the controls, recovery from the poisoning was delayed. After a dose of 300 milligrams per kilogram of coramine the narcosis was lightened for a time but soon a convulsive state developed which later passed into a deep de-

pression during which over 60 per cent of the animals died as compared with none of the untreated controls. When the dose of coramine was increased to 400 milligrams per kilogram the depression was deepened without evidence of a preliminary awakening action and all the animals died. From Maloney's extensive experiments therefore it appears that the smaller doses of coramine have no antidotal action against barbital in rats and that the larger doses are so consistently synergistic to its toxic effects that a combination of the 2 drugs results in a high mortality.

Hildebrandt concludes in his recent review of the available data that although a degree of antagonism to depressants may be elicited with the lower doses of coramine, the use of higher doses is apt to intensify the depression. This is in sharp contrast to the view frequently expressed in the clinical literature (Wood) to the effect that coramine possesses a wide margin of safety. This assertion is probably true when restricted to the margin between the doses causing respiratory stimulation and death of unanesthetized animals. It is apparently quite incorrect when applied to the margin between the doses causing respiratory stimulation and respiratory depression of deeply narcotized animals.

#### TECHNIQUE EMPLOYED

Measured per kilogram doses of ether and chloroform were administered to healthy mongrel dogs by the method described in a previous paper (4). In brief the apparatus is essentially a closed soda lime absorption system having approximately 5 liters capacity, within which the anesthetic is volatilized in an atmosphere of pure oxygen. The mask contains a rubber diaphragm through which by means of a syringe and needle, the dose of the anesthetic is injected on to a wire screen for volatilization. The mask is fitted tightly to the dog's muzzle by means of a rubber face piece. Every effort was made to prevent gas leakage at this point and the entire system was checked frequently for leaks. Volatilization of the anesthetic is rapidly completed and the drug develops its maximum effects within an average period of 2 minutes. Experiments were performed at intervals of 4 days.

The minimal dose of each of the two anesthetics required to produce an apparently permanent respiratory arrest was established for each animal by repeated experiments. For this purpose the initial dose employed was below the average of the series. It was then increased or decreased as required until we had determined the amount of the drug which produces an apparently permanent respiratory arrest in not less than 2 of 3 consecutive experiments and which, when reduced by 10 per cent, produces arrest in not more than 1 of 3 consecutive experiments. When the respiratory paralysis had lasted 15 seconds the mask was removed and the animal was resuscitated by artificial respiration and the administration of oxygen. After the minimal dose for respiratory arrest, as defined above, had been determined for each individual dog a second series of 3 anesthetics each consisting of the minimal dose for respiratory arrest was administered. As soon as the animal passed into surgical anesthesia a dose of 37.5 milligrams per kilogram of coramine was injected intravenously. (This dose of coramine is equivalent for the average adult human to 10 cubic centimeters of the commercial 25 per cent solution.) In the event of respiratory arrest the animal was resuscitated by the same method used for the controls.

The use of this technique has enabled us to study the influence of coramine upon the individually determined minimal dose for respiratory arrest of ether and of chloroform for dogs and to assay its efficiency as an aid to resuscitation following the minimum certainly fatal dose of these agents.

#### EXPERIMENTAL RESULTS

In the 19 animals given chloroform the minimal dose for respiratory arrest ranged from 0.145 cubic centimeters to 0.257 cubic centimeters per kilogram with a median of 0.185 cubic centimeters per kilogram. It is of interest to note that by analogy this would place the fatal dose of chloroform administered by the closed technique at less than 13 cubic centimeters for an average adult human. Undoubtedly many would die following a much smaller dose. The potency of the volatile anesthetics rapidly administered in a

closed system is thus much greater than is generally realized. The probable explanation for this phenomenon lies in the fact that, following a very rapid absorption the vital centers of the medulla receive an unduly large proportion of the drug as compared with the rest of the body. The danger associated with very rapid induction of anesthesia is obvious.

In the 10 animals given ether the minimal dose for respiratory arrest ranged from 1.1 cubic centimeters to 2.8 cubic centimeters per kilogram with a median of 1.75 cubic centimeters per kilogram.

The individual variation in susceptibility shown in our control experiments may appear unduly large to those unfamiliar with biological assay, but is probably no greater than has often been encountered in similar studies both in animals and in man. This question of individual variation in susceptibility was discussed in some detail in our previous paper (4).

Although the various individuals of a population undoubtedly differ greatly in susceptibility, it has been our experience that the susceptibility of any one dog tends to remain constant during a considerable series of anesthetics. That our dogs responded consistently is clearly shown by the great reduction in the percentage of respiratory arrests obtained when the minimal dose for respiratory arrest was reduced by 10 per cent. The accuracy of our method for determining the minimal dose for respiratory arrest of inhalation anesthetics is also illustrated by the fact that both the median minimal doses for respiratory arrest of ether and chloroform in this series of animals are within 6 per cent of those found in our previous group (4). In both series of dogs the ratio of the chloroform-ether minimal dose for respiratory arrest was found to be 1.94. We recognize, of course, that such exact correspondence of results must be accidental but we feel that our method provides controls of sufficient accuracy to permit bioassay of the analeptic action of drugs. Our results are briefly summarized in Table I.

It is apparent from Table I that, although the percentage of respiratory arrests can be diminished by reducing the minimal dose for respiratory arrest of the anesthetic by 10 per cent, the use of coramine is without effect.

TABLE I.—INFLUENCE OF CORAMINE ON THE MINIMAL DOSE REQUIRED TO PRODUCE RESPIRATORY ARREST

	Respiratory arrests	Non-arrests	Total administrations of M D R A	Per cent of arrests to total of administrations
*M D R A alone	28	8	36	78
M D R A plus coramine	21	7	28	75
M D R A reduced by 10 per cent	4	12	16	25
Chloroform				
M D R A alone	57	7	64	89
M D R A plus coramine	45	5	50	90
M D R A reduced by 10 per cent	6	29	35	17

\*The M D R A is the (M)inimal (D)ose required to produce (R)espiratory (A)rrrest

#### CORAMINE AS AN AID TO RESUSCITATION

Every scientist recognizes the truth of the ancient maxim, "The proof of the pudding is seen in the eating." Similarly, claims for analeptic action are best tested during resuscitation. Unfortunately, this fact has not always received the consideration it deserves.

During the course of the experiments described we have carried out 161 resuscitations from the measured minimal dose of ether and chloroform for respiratory arrest. This has given us the opportunity to determine the influence of coramine upon the probability of resuscitation. In 95 control experiments, resuscitation was carried out by means of artificial respiration and the administration of oxygen alone. In the remaining 66 experiments, 37.5 milligrams per kilogram of coramine were injected intravenously with the onset of surgical anesthesia. Fifteen seconds after respiratory arrest the animal was resuscitated by the same means employed for the controls. Our experience is summarized in Table II.

As Table II shows, there were no failures to resuscitate from the minimal dose of ether required for respiratory arrest in 53 attempts either with or without coramine. We have been unable, therefore, to obtain any information concerning the value of coramine in the treatment of ether overdose. There was no indication that coramine increased the ease or speed of resuscitation. Occasionally, a tempo-

TABLE II — INFLUENCE OF CORAMINE ON THE PROBABILITY OF RESUSCITATION

Ether	Respiratory Arrests	Fa Jures to resuscitate	Per cent of failures to resuscitate
M D R A. without coramine	33	0	00
M D R A. with coramine	25	0	00
Chloroform			
M D R A. without coramine	63	4	6
M D R A. with coramine	45	5	55

\* M D R A. is the (M)imal (D)ose refered to produce (R)espiratory (A)rrrest

rary stimulation of the respiration occurred, especially when the injection happened to be made relatively early in the surgical stage of anesthesia, but usually this did not persist into the late toxic stage.

The higher mortality from chloroform overdose provides a much better opportunity of studying the influence of coramine upon the ease and certainty of resuscitation. As indicated in the table, the use of coramine almost doubled the mortality from an overdose of chloroform.

#### IMPORTANCE OF THE CIRCULATORY EFFECTS OF AN ANALEPTIC

Although the respiratory and circulatory functions are equally necessary for life yet from the viewpoint of resuscitation, there is an essential difference. By means of artificial respiration etc. it is possible to efficiently substitute for failure of breathing but for cessation of circulation little or nothing can be done. The end result, therefore, of any attempt at resuscitation depends ultimately upon the behavior of the circulation. For this reason the action of an analeptic upon the circulation must be of much greater importance than its respiratory effects. Notwithstanding this, certain substances considered by pharmacologists to be potential cardiac poisons (3, 25) have been used as analeptics.

Experimental investigations of the circulatory action of coramine have yielded some what equivocal results. It seems well established that coramine, under favorable circumstances is capable of raising the blood

pressure. Stros and Van Esveld believe that the pressor effect is due entirely to a central action. This stimulation of the vasomotor center appears to be part of a generalized medullary excitation which involves, in addition, the respiratory, cardioinhibitory, and vomiting centers. The results obtained by several investigators indicate that the pressor action is often absent when the blood pressure has been lowered by circulatory poisons. Thus Issekutz found that severe circulatory collapse induced by chloroform was not improved by coramine. On the contrary, it caused a prolonged fall in blood pressure and dilatation of the heart. Somewhat more favorable results were obtained by Russu and Spärchez who report a few experiments in which coramine apparently prevented adrenalin chloroform collapse. Trendelenburg found coramine inactive against cardiac and vasomotor insufficiency whether produced by novocain, histamine, or chloral hydrate.

A favorable action on the contractions of the isolated heart following perfusion by a 1:50,000 solution of coramine was described in 1924 by Uhlmann but a number of subsequent workers (Trendelenburg, Gremels, Leyko, Gollwitzer Meier, and Peters and Visscher) have failed to confirm his results.

The results of Peters and Visscher are worthy of comment. Using the Starling heart lung preparation these workers found that coramine dilates the heart and diminishes its output and metabolic efficiency.

Thus a review of the available data seems to indicate that the central vasopressor action of coramine is frequently absent in severe poisoning and that the drug exerts no significant favorable action upon the insufficient heart. Certain investigators have found it even definitely injurious.

The injurious effects upon the chloroform poisoned heart observed by Issekutz and others are an adequate explanation for the fact that, in our hands, the use of coramine almost doubled the mortality from an overdose of chloroform.

#### SUMMARY AND CONCLUSIONS

1. A new method for the determination of the analeptic value of drugs is proposed.

2 Coramine does not increase the dose of ether or chloroform required to produce respiratory arrest in dogs

3 Resuscitation by means of artificial respiration and the administration of oxygen from respiratory arrest produced by measured doses of ether was uniformly successful in 53 attempts with or without the use of coramine. There was no evidence that coramine increased the ease or speed of resuscitation

4 In 63 experiments, during which respiratory arrest was produced by measured doses of chloroform, there were 4 or 6 per cent failures to resuscitate by means of artificial respiration and oxygen. In 45 similar experiments in which, in addition to this procedure, coramine was injected just before respiratory arrest, there were 5 or 11 per cent failures to resuscitate. Thus, the use of coramine, in our hands, almost doubled the mortality from an overdose of chloroform

## BIBLIOGRAPHY

- 1 AXMACHER, F Arch f exper Path u Pharmacol, 1936, 183 478
- 2 BARLOW, O W J Pharmacol & Exper Therap, 1935, 55 1
- 3 CAMP, W J R J Pharmacol & Exper Therap, 1927, 31 393
- 4 DRAPER, W B, and WHITEHEAD, R W Surg, Gynec & Obst, 1938, 67 436
- 5 LICHLER, O, and KLEIN, H W Ztschr f d ges exper Med, 1936, 99 28

- 6 GOLLWITZER-MEIER, K Klin Wchnschr, 1936, 15 508
- 7 GREMELS, H Arch f exper Path u Pharmacol, 1930, 153 36
- 8 GUNS, P Arch internat de pharmacod et de therapie, 1926, 32 373
- 9 HILDEBRANDT, T Hefiter's Handb d exper Pharmacol, 1937, 5 139
- 10 ISSEKUTZ, B V Arch f exper Path u Pharmacol, 1935, 177 415
- 11 KILLIAN, H Klin Wchnschr, 1931, 10 1446; 1933, 12 192
- 12 KOHLHOFF, H Arch f exper Path u Pharmacol, 1928, 136 331
- 13 LENDLE, L Arch f exper Path u Pharmacol, 1936, 181 408
- 14 LEVKO, E J Pharmacol & Exper Therap, 1930, 38 31
- 15 MALONEY, A H, and TATUM, A L Arch internat de pharmacod et de therapie, 1932, 42 200
- 16 MALONEY, A H Quart J Exper Physiol, 1935, 25 155
- 17 MORITSCH, P Arch f exper Path u Pharmacol, 1932, 168 249
- 18 PETERS, H C, and VISSCHER, M B Am Heart J, 1936, 11 273
- 19 RUSSU, I G, and SPÂRCHEZ, T Ztschr f d ges exper Med, 1936, 98 772
- 20 STROSS, W Arch f exper Path u Pharmacol, 1928, 130 326
- 21 TRENDLENBURG, P Med Klin, 1929, 25 1573
- 22 UHLMANN, F Ztschr f d ges exper Med, 1924, 43 556
- 23 VAN ESVELD, L W Arch f exper Path u Pharmacol, 1930, 149 348
- 24 WAGNER, K Diss Giessen, 1931 (quoted by Hildebrandt loc cit, 9)
- 25 WHITEHEAD, R W, and ELLIOTT, D C J Pharmacol & Exper Therap, 1927, 31 145
- 26 WOOD, P M Am J Surg, 1933, 22 86
- 27 ZIPF, K, WINDSCHUS, W A, and KOROSCHKA, F Arch f exper Path u Pharmacol, 1937, 185 113

# CERVICAL STUMP CARCINOMA

MARION E. BLACK, M.D. Cleveland, Ohio

**A** CLINICAL study of a series of our cases of carcinoma of the cervix was prompted by the increasing number of cancers of the cervix we have seen following supracervical hysterectomy. Over a 5 year period, from July, 1932, to July, 1937, 234 consecutive cases of carcinoma of the cervix were admitted to the University Hospitals of Western Reserve University. The diagnosis in each case was substantiated by a histological study of tissue removed by biopsy.

## AGE INCIDENCE, RACE, AND PARITY

On admission, 157 patients (67 per cent) were between the ages of 40 and 60, 39 (16.6 per cent) were over 60 years of age. There were 38 patients under 40 years of age, 7 patients were between 25 and 29 years. There were 9 patients between 70 and 79 years. The youngest patient was 25 years of age, the oldest 73 years. The average age for the entire group was 49 years (Table I).

There were 190 (81.2 per cent) white patients, and 44 (18.8 per cent) colored. The multiparæ numbered 211 (90.7 per cent), there were 23 (9.3 per cent) nulliparæ.

## MENAPAUSE, MENARCHE RELATIONSHIP AND REGULARITY OF THE MENSTRUAL CYCLE

In this group data were complete in 215 cases. Sixty-two patients (28.8 per cent) in the premenopausal group had not exhibited any of the nervous manifestations of the menopause and their periods had been regular.

From the Department of Obstetric and Gynecology, Western Reserve University School of Medicine and the University Hospital.

TABLE I — AGE INCIDENCE

Decade*	Patients	Percent
20-29	7	2.9
30-39	31	13.2
40-49	84	35.9
50-59	73	31.1
60-69	30	12.8
70-79	9	3.8

\*The youngest patient was 25 years, the oldest 73 years. Average age 49.

prior to the onset of symptoms. One hundred five patients (48.8 per cent) were definitely in the menopause when their symptoms began. In 48 patients (22.3 per cent) no definite symptoms of the menopause existed except irregular bleeding which may have been due to the existing carcinoma.

This group includes the 10 patients who had had a supracervical hysterectomy.

The pre- and postmenopausal groups were checked for the age at menarche, and the records were complete in 104 cases. In the postmenopausal group 108 had an average menarche age of 13.5 years. The premenopausal group of 56 cases had an average menarche age of 13.5 years.

From the records 182 cases were obtained with accurate menstrual history. In the postmenopausal group 117 (64.2 per cent) had a regular cycle up to the menopause, 4 (2.2 per cent) had an irregular cycle. In the premenopausal group 60 (37.9 per cent) had a regular cycle, 1 (0.5 per cent) had an irregular cycle.

The occurrence of carcinoma as to premenopausal and postmenopausal grouping conforms to the age incidence of the entire group studied. The menarche relationship and the regularity of the menstrual flow were similar to that found in a group of non-cancerous patients (Table II).

TABLE II  
Menopausal Relationship

	Number	Percent
Premenopausal	62	28.8
Postmenopausal	105	48.8
Intermediate	48	22.3

Menarche Relationship

	Number	Average	Percent
Premenopausal	56		13.5
Postmenopausal	108		13.5

Regularity of the Menstrual Cycle

	Number	Percent
Postmenopausal group	117	64.2
Irregular	4	2.2
Premenopausal group	60	37.9
Irregular	1	0.5

TABLE III.—ASSOCIATED LESIONS AND PREVIOUSLY EXISTING PELVIC LESIONS

Type of lesion	Patients	
	Number	Per cent
Fibromyoma uteri	16	6.8
Secondary anemia	14	5.9
Syphilis	13	5.5
Diabetes mellitus	9	3.8
Salpingitis, chronic	6	2.5
Atypical hyperplasia endometrium	5	2.1
Pyometra	4	1.7
Ectopic pregnancy	5	2.1
Pelvic abscess	3	1.3
Carcinoma elsewhere	3	1.3
Procidencia uteri	1	0.5

## ASSOCIATED LESIONS AND PREVIOUS PELVIC LESIONS (TABLE III)

The occurrence of fibromyoma in this group was the most frequently associated lesion, occurring in 16 patients (6.8 per cent). There was a surprisingly low number of patients with secondary anemia, 14 (5.9 per cent), in view of the fact that the most common complaint was vaginal bleeding.

Diabetes occurred in 9 (3.8 per cent), and syphilis in 13 (5.5 per cent). The degenerative diseases, generalized arteriosclerosis and hypertensive cardiovascular disease, were the most commonly found, which would be expected in a group of patients in which the average age is 49 years. Ten patients had gall-bladder disease or their condition had been previously diagnosed as such.

The most common associated pathological lesion of the pelvis, excepting fibromyoma, was chronic salpingitis in 6 (2.5 per cent) patients. Five patients (2.1 per cent) had atypical hyperplasia of the endometrium. Five (2.1 per cent) had had previous salpingectomies for ectopic pregnancy. Four (1.7 per cent) had an existing pyometra at the time of radiation. Pelvic abscess occurred in 3 (1.3 per cent) cases. One patient had a complete procidentia uteri.

Concomitantly with malignancy of the cervix, cancer occurred elsewhere in 3 patients (1.3 per cent), 1 had an epithelioma of the face, 1, malignancy of the left breast, and 1, scirrhous carcinoma of the stomach.

## PREVIOUS PELVIC OPERATIONS (TABLE IV)

A previous pelvic operation had been performed in 49 patients (20.9 per cent). 19 of

TABLE IV

Previous pelvic operations	Patients	
	Number	Per cent
Unilateral salpingectomy	7	14.2
Unilateral oophorectomy	3	6.1
Unilateral salpingo-oophorectomy	3	6.1
Suspension of the uterus	3	6.1
Bilateral salpingectomy	2	4.1
Bilateral salpingo-oophorectomy	2	4.1
Bilateral oophorectomy	2	4.1
Trachelorrhaphy	2	4.1
Drainage of pelvic abscess	2	4.1
Interposition operation	1	2.0
Cauterization of the cervix	1	2.0
Amputation of the cervix	1	2.0
Myomectomy	1	2.0
Supracervical hysterectomy	19	38.7

whom had supracervical hysterectomies. Seven patients (14.2 per cent) had unilateral salpingectomies. Three patients (6.1 per cent) had unilateral oophorectomies, three (6.1 per cent) had unilateral salpingo-oophorectomies, three (6.1 per cent) had suspensions of the uterus. Two patients (4.1 per cent) had bilateral salpingectomies, 2 (4.1 per cent) had bilateral salpingo-oophorectomies, 2 (4.1 per cent) trachelorrhaphies, 2 (4.1 per cent) bilateral oophorectomies, and 2 (4.1 per cent) drainage of the pelvis for a pelvic abscess. One patient each had the following: interposition operation, amputation of the cervix, and myomectomy.

## PRECEDING SYMPTOMS AND THEIR DURATION (TABLES V AND VI)

The predominating symptom was vaginal bleeding, occurring in 187 patients (79.9 per cent). This varied from intermenstrual spotting to menorrhagia and metrorrhagia. Vaginal discharge occurred in 94 patients (40.1 per cent), in the form of a foul, watery, white, or brown discharge. A watery discharge was the most common type found. Backache occurred in 28 (11.9 per cent). Loss of weight was noted in 26 (11.1 per cent). Bleeding, in the form of spotting only after intercourse or douching was present in 24 (10.2 per cent), not associated with any other type of bleeding and apparently entirely due to trauma. There was frequency of urination, dysuria, or nocturia in 46 (19.6 per cent), and constipation in 12 patients (5.1 per cent). The majority of the patients had 2 or more of the above symptoms. There were 25 patients who had no



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In this group data were complete in 215 cases. Sixty-two patients (28.8 per cent) in the premenopausal group had not exhibited any of the nervous manifestations of the menopause and their periods had been regular

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This group includes the 19 patients who had had a supracervical hysterectomy.

The pre- and postmenopausal groups were checked for the age at menarche and the records were complete in 164 cases. In the postmenopausal group 108 had an average menarche age of 13.5 years. The premenopausal group of 56 cases had an average menarche age of 13.5 years.

From the records 182 cases were obtained with accurate menstrual history. In the postmenopausal group 127 (64.2 per cent) had a regular cycle up to the menopause, 4 (2.2 per cent) had an irregular cycle. In the premenopausal group 60 (32.9 per cent) had a regular cycle, 2 (0.3 per cent) had an irregular cycle.

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TABLE II  
Menopausal Relation ship

	Number	Percent
Premenopausal	62	28.8
Postmenopausal	103	48.8
Indeterminate	48	22.3

Menarche Relation ship

	Number	Average Age at Menarche	Percent
Premenopausal	55	13.5	25.5
Postmenopausal	109	13.5	50.5

Regularity of the Menstrual Cycle

	Number	Percent
Postmenopausal group	117	64.2
Pre-menopausal group	4	2.2
Pre-menopausal group	60	31.9
Pre-menopausal group	1	0.5

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Pelvic abscess	3	1.3
Carcinoma elsewhere	3	1.3
Procidentia uteri	1	0.5

## ASSOCIATED LESIONS AND PREVIOUS PELVIC LESIONS (TABLE III)

The occurrence of fibromyoma in this group was the most frequently associated lesion, occurring in 16 patients (6.8 per cent). There was a surprisingly low number of patients with secondary anemia, 14 (5.9 per cent), in view of the fact that the most common complaint was vaginal bleeding.

Diabetes occurred in 9 (3.8 per cent), and syphilis in 13 (5.5 per cent). The degenerative diseases, generalized arteriosclerosis and hypertensive cardiovascular disease, were the most commonly found, which would be expected in a group of patients in which the average age is 49 years. Ten patients had gall-bladder disease or their condition had been previously diagnosed as such.

The most common associated pathological lesion of the pelvis, excepting fibromyoma, was chronic salpingitis in 6 (2.5 per cent) patients. Five patients (2.1 per cent) had atypical hyperplasia of the endometrium. Five (2.1 per cent) had had previous salpingectomies for ectopic pregnancy. Four (1.7 per cent) had an existing pyometra at the time of radiation. Pelvic abscess occurred in 3 (1.3 per cent) cases. One patient had a complete procidentia uteri.

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Unilateral salpingo-oophorectomy	3	6.1
Suspension of the uterus	3	6.1
Bilateral salpingectomy	2	4.1
Bilateral salpingo-oophorectomy	2	4.1
Bilateral oophorectomy	2	4.1
Trachelorrhaphy	2	4.1
Drainage of pelvic abscess	2	4.1
Interposition operation	1	2.0
Cauterization of the cervix	1	2.0
Amputation of the cervix	1	2.0
Myomectomy	1	2.0
Supracervical hysterectomy	19	38.7

whom had supracervical hysterectomies. Seven patients (14.2 per cent) had unilateral salpingectomies. Three patients (6.1 per cent) had unilateral oophorectomies, three (6.1 per cent) had unilateral salpingo-oophorectomies, three (6.1 per cent) had suspensions of the uterus. Two patients (4.1 per cent) had bilateral salpingectomies, 2 (4.1 per cent) had bilateral salpingo-oophorectomies, 2 (4.1 per cent) trachelorrhaphies, 2 (4.1 per cent) bilateral oophorectomies, and 2 (4.1 per cent) drainage of the pelvis for a pelvic abscess. One patient each had the following interposition operation, amputation of the cervix, and myomectomy.

## PRECEDING SYMPTOMS AND THEIR DURATION (TABLES V AND VI)

The predominating symptom was vaginal bleeding, occurring in 187 patients (79.9 per cent). This varied from intermenstrual spotting to menorrhagia and metrorrhagia. Vaginal discharge occurred in 94 patients (40.1 per cent), in the form of a foul, watery, white, or brown discharge. A watery discharge was the most common type found. Backache occurred in 28 (11.9 per cent). Loss of weight was noted in 26 (11.1 per cent). Bleeding, in the form of spotting only after intercourse or douching was present in 24 (10.2 per cent), not associated with any other type of bleeding and apparently entirely due to trauma. There was frequency of urination, dysuria, or nocturia in 46 (19.6 per cent), and constipation in 12 patients (5.1 per cent). The majority of the patients had 2 or more of the above symptoms. There were 25 patients who had no

TABLE V —PRECEDING SYMPTOMS

Patients	Number	Per cent
Vaginal bleeding	187	79.9
Vaginal discharge	94	40.1
Lower abdominal pain	60	25.0
Backache	28	11.9
Loss of weight	26	11.1
Spotting after intercourse douching	24	10.2
Frequency of urination, dysuria		
nocturia	46	19.6
Constipation	12	5.1
No history of bleeding	35	10.7

TABLE VI —DURATION OF SYMPTOMS BEFORE DIAGNOSIS

Patients	Number	Per cent
Time		
1 week to 1 year	185	79.0
1 year to 10 years	49	20.9

history of bleeding and whose only complaint was a vaginal discharge usually associated with backache or lower abdominal pain.

The duration of symptoms varied from 1 week to 10 years before the diagnosis was made. There were 185 patients (79 per cent) whose duration of symptoms before diagnosis was 1 week to 1 year, 49 patients (20.9 per cent) whose duration of symptoms was over 1 year, and 1 patient who had shown marked irregular bleeding for the past 10 years. Most of this patient's symptoms could be accounted for by causes other than the existing carcinoma. A fair estimate of the average duration of symptoms due alone to carcinoma is difficult to evaluate. Taking the first group as a fair estimate the average duration of symptoms would be 4½ months. The relatively short duration of symptoms and the usual finding that the growth has spread beyond the cervix as shown in this series and as has been stated in the literature, demonstrate the importance of a careful cervical examination as part of any adequate physical check up in women. Pomeroy estimates 8 months as the average interval between the onset of symptoms and the time the patient first sees the doctor.

#### TYPE OF CARCINOMA AND CLINICAL CLASSIFICATION OF EXTENT OF GROWTH

There were 215 patients (91.9 per cent) who had squamous cell carcinoma, 19 (8.1 per cent) had adenocarcinoma of the cervix.

TABLE VII

Patients	Number	Per cent
Type of Carcinoma		
Squamous-cell	215	91.9
Adenocarcinoma	19	8.1
Clinical classification		
Group A	21	8.0
Groups B and C	154	65.8
Group D	33	14.1
*Out of the 234 patients only 8.0 per cent were limited to the cervix.		

The clinical classification used is that of the American College of Surgeons. Twenty-one patients (8.9 per cent) were classified in Group A (limited to the cervix). There were 154 patients (65.8 per cent) in Groups B and C (broad ligament and vaginal involvement). Thirty-three patients (14.1 per cent) were classified in Group D (wide fixation). There were 26 patients not clinically classified.

#### TREATMENT

Only the initial treatment during the patients' hospitalization is reported. Of the total number 190 patients were given radium in the form of radium tube in the cervical canal or implantation of radium seeds in the cervix. The usual treatment was a combination of the tube and radium seeds. The average dosage of radium was 4,742 millicurie hours.

Fourteen patients (5.9 per cent) were considered too far advanced for any treatment. Eleven patients were treated by panhysterectomy and 3 patients by vaginal hysterectomy. These cases with operation include 8 patients on whom vaginal or abdominal panhysterectomy was done and carcinoma of the cervix was found incidentally. Four patients received deep x-ray therapy only. Five patients were given deep x-ray therapy to be followed by radium. In 7 patients previous diagnosis had been made and treatment carried out elsewhere for carcinoma of the cervix.

**Complications following treatment.** This includes only the initial complications during the patients' hospital stay. The average length of the hospital course was 5 days. Complications occurred in 10 patients (4.2 per cent). Two patients developed pelvic peritonitis. Two patients had a phlebitis of the sphenous vein. The following complications were each noted once, stricture of the urethra, recto-

TABLE VIII —AGE—STUMP CARCINOMA

Years	Patients Number	Per cent
2-4	10	52.6
8-17	5	26.3
20-36	4	21.1

vaginal fistula, pyometrium, necrosis of the uterine artery with a fatal hemorrhage, peritonitis from an instrumental wound of the uterus, and an instrumental wound of the uterus with no complication. There has been no follow-up on any of the patients studied because diagnosis was made in all and treatment was carried out in the last 5 years.

#### INCIDENCE OF CARCINOMA OF THE CERVIX FOLLOWING SUPRACERVICAL HYSTERECTOMY

Of the 234 carcinoma patients coming to the hospital during the past 5 years, 19 or 8.1 per cent had had a supracervical hysterectomy previously. Diagnosis of the carcinoma of the cervix in all cases was made 2 or more years after the operation, so that it is reasonable to believe that at the time of the subtotal hysterectomy, the carcinoma was not present.

Ten of the patients or 52.6 per cent developed cancer from 2 to 4 years following the operation. In 5 patients or 26.3 per cent the cancer occurred 8 to 10 years following the operation, and in 4 patients or 21.1 per cent it occurred 20 to 36 years after the operation. The shortest interval was 19 months (this occurred in only one patient) and the longest interval was 36 years.

#### AGE, PARITY, AND RACE IN STUMP CARCINOMA

The average age for the group of 19 patients was 49 years; the same average age as found for the entire group of 234. Sixteen patients (84.2 per cent) were multiparæ, three (15.7 per cent) were nulliparæ, which shows a higher percentage of nulliparæ than that found in the entire group. This is in accord with the figures published by Meigs who found 25 per cent of stump cancer occurred in nulliparæ. Von Graff found 22 per cent of 300 stump cancers had never been pregnant.

Fifteen patients were white (78.9 per cent) and 4 were colored (21.1 per cent).

#### CLINICAL CLASSIFICATION OF EXTENT OF GROWTH IN STUMP CARCINOMA

The grouping of the estimated involvement present was that suggested by the American College of Surgeons. Upon this basis 2 patients (10.5 per cent) were class 4 A (limited to the cervix). Ten patients (52.6 per cent) were classes 4 B and 4 C (extension to the vaginal wall and involving the broad ligaments). Four patients (21.1 per cent) were class 4 D (wide fixation). Three patients (15.8 per cent) were not classified as to extent of growth.

*Type of carcinoma.* Seventeen patients (89.4 per cent) had squamous-cell carcinoma. Two patients (10.5 per cent) had adenocarcinoma.

#### REMARKS

In this clinical review the data collected conforms with that which has been reported in the literature. The balancing together of the relatively short duration of symptoms, likely to be confused with menopausal changes, and the far advanced stage of the carcinoma when found, leads inevitably to the poor results in treatment universally reported in the literature.

Particularly interesting is the 8.1 per cent of stump cancer found in this review. Ward and Sackett report in their clinic 56 cases in 752 patients, a percentage of 7.4. The interval in 25 cases was less than 3 years, and more than 3 years in 31 cases. Farrar, at Women's Hospital in New York, found stump cancer which had developed one or more years after hysterectomy in 7 per cent of the cervical cancers. Meigs in 1218 cervical cancers found 26 or 2.1 per cent. This he presented as the corrected figure from 80 stump cancers found, eliminating 22 which were recurrences in the vault following panhysterectomy and 23 found within 1 year after operation, probably present at the time of operation, and 9 cases following subtotal hysterectomy for adenocarcinoma of the fundus. Healy and Arenson found 67 stump cancers (2.6 per cent) among 2600 cancers of the cervix at the Memorial Hospital, New York.

Nuttall and Todd divide their cases of carcinoma of the cervical stump into 2 groups as to prognosis. Group A, carcinoma present at

the time of operation, and Group B, carcinoma discovered 2 or more years after hysterectomy. The prognosis in Group A is bad, analogous to results obtained in carcinoma elsewhere in the body, because of the presence of a malignant process an incomplete operation is done. In our findings all stump cancers occurred 2 years or more following supracervical hysterectomy, but 52.6 per cent were discovered in the 2 to 4 year period following the operation.

Schiller emphasizes the prodromal stage of carcinoma of the cervix, i.e., months to several years may elapse before the surface cancer becomes active and begins to penetrate the deeper tissues. This Schiller designates as the primary stage of carcinoma of the cervix. The activation of a precancerous lesion of the cervix by a subtotal hysterectomy in the 52.6 per cent of the cases seems to be a definite possibility. Thus, in our opinion, is a potent argument in favor of the total operation.

The importance of pre operative examination of the cervix, when a hysterectomy is contemplated, and especially the subtotal opera-

tion, must be stressed. When the subtotal operation has been performed, the patient's cervix should be observed at regular intervals after operation making use of all modern methods of examination: the colposcope, the iodine test as advocated by Schiller followed by a study of tissue removed at biopsy from any suspicious lesion thus demonstrated.

#### BIBLIOGRAPHY

1. TARRAR L. K. P. Total abdominal hysterectomy. *Surg. Gynec. & Obst.* 1935 60 827.
2. HEALY W. P. and ARENSON V. N. Carcinoma of the cervical stump. *Am. J. Obs. & Gynec.* 1935 v 370.
3. MEIGS J. V. Carcinoma of the retained cervix or subtotal versus total hysterectomy. *Am. J. Obst. & Gynec.* 1936 31 358.
4. NUTTALL J. R. and TODD T. F. Prognosis in carcinoma of the cervical stump after subtotal hysterectomy: analysis of 38 Cases. *J. Obst. & Gynec. Brit. Emp.* 1936 42 860.
5. POMEROY, L. A. Carcinoma of cervix uteri: five year results of radium treatment. *Surg., Gynec. & Obst.* 1933 57 671.
6. SCHILLER W. Clinical behavior of carcinoma of the cervix. *Surg. Gynec. & Obst.* 1938 66 129.
7. VON GRAFF E. Cancer of the cervical stump. *Am. J. Obst. & Gynec.* 1934 28 18.
8. WARD G. G. and SACKETT N. B. Results of radiation therapy for carcinoma of the uterus. *J. Am. M. Ass.* 1938 110 323.

# UNUSUAL LESIONS OF MUSCLES AND TENDONS OF THE SHOULDER GIRDLE AND UPPER ARM

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**N**O surgeon ever sees many ruptures of muscles of the shoulder girdle and upper arm and, therefore, even a report of a few cases and a review of the literature should be enlightening. We shall confine our remarks to lesions of the deltoid, supraspinatus, serratus magnus, pectoralis major, subscapularis, coracobrachialis, triceps, and biceps muscles.

## LESIONS OF THE DELTOID MUSCLE

The deltoid muscle is an abductor of the arm, and its 3 portions, anterior or clavicular, acromial or intermediate, and scapular or posterior take part in this motion of elevation (41). According to Duchenne (41), the posterior fibers alone cannot abduct the arm more than to 45 degrees, while the anterior ones are the most powerful and are capable of abducting the arm to 90 degrees.

Lesions of the deltoid may involve the muscle itself or its nerve, or both. These lesions may or may not be associated with injuries to other muscles or nerves, they may follow direct or indirect trauma, or an inflammatory process of the muscle, nerve, or surrounding structures (5). Lesions of the axillary nerve, formerly called circumflex, are usually the most common cause of paralysis, and often are associated with paralysis of other muscles of the shoulder girdle (43).

In a review of the literature, we found that Bunts reported and tabulated 19 cases of isolated injury to the circumflex nerve, of these, 8 were the result of dislocation and 7 of a contusion of the shoulder. He also reviewed the history of nerve injuries about the shoulder joint and said that paralysis of the arm as a complication of luxation of the shoulder had been mentioned by Erasistratus in

300 B C, and reported by Galen in his *Officina Medici*. According to Bunts, however, it was not until Desault mentioned an injury to the deltoid muscle itself following luxation of the shoulder, that this lesion received recognition which has increased since then. In our review of the literature, we have been unable to find any case reported of injury to the deltoid muscle itself with the exception of the one by Clemens in 1913. This was a case of traumatic hernia of the deltoid muscle in a man whose arm was suddenly jerked when his co-worker by mistake dropped one end of a track they were moving. The patient felt intense pain in his arm, and later in the middle of the right deltoid noticed a tumor which caused him pain when moving the arm. This tumor became bigger and harder on contraction of the deltoid; and while the patient complained of it a great deal, he was not incapacitated. He declined operation. Clemens at that time commented on the rarity of a hernia of the deltoid muscle and stated that he had been unable to find a single case reported in the literature. Davis, in 1919, reported a case of detachment of the deltoid muscle from its bony origin following suppuration due to osteomyelitis of the right clavicle. He described how he had bridged the gap between the retracted deltoid and its normal origin by implantation with fascia from the thigh.

Smith and Christensen, in 1925, said that the mechanism of production of paralysis of the deltoid muscle is not explained in the repeated references found in the literature. They reported 2 cases of paralysis with definite solution of continuity of the circumflex nerve one inch from the origin, which followed blows on the shoulder and which was verified at operation. They emphasized that even common shoulder injuries, without penetration or lacerations, may result in a complete and permanent paralysis of the deltoid muscle.

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*Symptoms of traumatic lesions of the deltoid muscle vary according to type and extension of the injury and the time elapsed after the injury. Those involving the muscle itself are easily recognized by the alteration in contour of the shoulder which is increased on active movements of the deltoid muscle and more so on movements performed against resistance. The alteration of contour will depend also on the site and extent of the lesion. Usually it is in the body of the muscle, more so toward the lower attachment (Figs 1 and 2). At this point one may see and feel a groove or hiatus, the depth of which varies according to the extent of the lesion, and proximal to the hiatus is a tumor which hardens and increases in size and may move proximally on active abduction of the arm. This tumor, like all subcutaneous muscular ruptures, is not attached to the skin and is movable under it when the muscle is relaxed and becomes more fixed when it is contracted. There may or may not be an extensive ecchymosis, according to the time when the rupture is seen. Usually it is more evident a few days after the injury and may extend down to the hand. When the lesion involves the axillary nerve itself (Sherren believes this not as common as textbooks infer) or the fibers of other brachial plexus nerves, the symptomatology is different and the extent of paralysis depends on where the lesion is produced, i.e. the cervical, axillary, or humeral portion of nerve (5).*

Usually there is a paralysis of the deltoid muscle which atrophies. The contour of the shoulder is flattened. This wasting away of the muscle makes the acromion process more prominent. The head of the humerus, however, does not tend to fall away from the glenoid cavity as it does when the spinatous muscles also are affected (43). As Bunts has remarked 'the appearance is not at first glance unlike that of dislocation of the shoulder joint. In extreme cases the great relaxation and thinning of the deltoid make it possible to feel the groove between the neck of the scapula and the head of the humerus and it has very frequently occurred that this deformity has been incorrectly diagnosed or interpreted as an unreduced dislocation of the head of the humerus (5).'

Sensory changes always accompany injuries to the axillary nerve, these changes involving loss of epicritic and protopathic sensibility over an area corresponding to the deltoid muscle (43).

Diagnosis at times is made easily by inspection in cases of rupture of the muscle. The tumor at this site, which changes its size and consistency on active movements, the hiatus, etc., are all sufficient signs to make a diagnosis of rupture. When atrophy and paralysis are present instead, the diagnosis is more difficult, as the problems then to be solved are recognition of a nerve injury, its type, its location, and its extension. The reactions of degeneration of various nerves and muscles of the shoulder girdle and sensory changes have to be investigated. Sherren has laid down the rule that "paralysis of the deltoid without sensory changes is due to interference with the function of the fifth cervical nerve and not with the circumflex."

The functional disability, prognosis, and treatment also depend on the extent of the lesion and whether it involves the muscle, the nerve, or both. Injuries to the axillary nerve alone, or to other nerves, are always followed by a severe degree of paralysis which may involve the other muscles besides the deltoid, thus increasing the functional disability and making the prognosis practically hopeless. This is true especially if ankylosis follows the paralysis as a result of a failure of development of synergistic muscles. If the deltoid alone is involved other muscles in the shoulder which normally have a synergistic action, may develop and assume a compensatory action (5). Such function, however, by careful and intelligent development may be assumed by other muscles, the action of which normally is not synergistic to that of the deltoid, such as the serratus magnus, middle part of the trapezius and pectoralis major (50). The supraspinatous muscle alone or with these other muscles, has been reported to have assumed the function of the deltoid.

Bunts has stressed the necessity of examining for injury to the axillary nerve after a dislocation of the shoulder with consecutive compression of the nerves and vessels in the axilla, or following blows or falls on the shoulder.

der in which instance the mass of the deltoid may not act as a sufficient protective layer. Thus we would often make a more serious prognosis in injuries which at first may appear to be insignificant.

*Treatment* Injuries to the deltoid muscle are to be repaired as soon as possible, and the after-treatment consists of an abduction splint at 90 degrees in a slightly forward position from 3 to 4 weeks, supplemented by gentle massage and heat starting about 1 week after the repair. This is to be followed by passive abduction of the shoulder by stooping-over exercises as outlined by E. A. Codman. The treatment of injuries to the nerves depends on the extent of damage produced, and ranges from the usual treatment of a neuritis to neurolysis or neurorrhaphy for the restoration of the continuity of the injured nerve or nerves. This is done by suturing the torn ends and by freeing the adhesions and cicatricial tissue which follow the trauma and which, especially in "aged individuals in whom a tendency to neurofibrosis exists" (5), is also apt to lead to actual complete paralysis of the nerves from the pressure exerted upon the circumflex nerve or its branches by the surrounding fibrous tissue (5).

While on the subject of injuries to the deltoid muscle and the axillary nerve, let us remember the damage that may be done by the surgeon who operates on the shoulder, especially for bursitis, and carries his incision on the lateral aspect of the shoulder for a distance greater than 6 centimeters from the tip of the acromion. If this is done, severing the axillary nerve is unavoidable with resulting paralysis of the fibers of the deltoid muscle anterior to the incision. Mayer, in 1937, reported 3 such instances following an operation for the repair of ruptured supraspinatous tendons.

In cases of severe atrophy of the deltoid, many plastic operations have been devised to substitute for the lack of power of abduction of this muscle, such as transplanting of the pectoralis, etc. Lemperg reported a case in which he shortened the clavicle, and succeeded in pulling the deltoid over the acromion to about the middle of where it inserts. He obtained a good functional result (abduction to 90 degrees), and a fairly good cosmetic one

with the exception of a slight winging of the scapula.

#### RUPTURE OF THE SUPRASPINATOUS TENDON

Codman, of Boston, has been a pioneer in lesions of the supraspinatus and the subacromial bursæ. His remarkable book, *The Shoulder* as well as his various articles, chiefly considers lesions of that muscle and its tendon, and is a masterpiece of surgical literature, worthy of careful study by all desiring to become familiar with a much neglected subject. Never before have the anatomy, physiology, and pathology of the shoulder been so thoroughly reviewed and discussed.

Patients with lesions of the supraspinatous muscle are disabled from carrying on any laborious occupation because of the important rôle played by this muscle and tendon in the function of the shoulder. When one familiarizes himself with the subject, he cannot but agree with Codman that all of these patients, even those in which we are in doubt, should be given the benefit of an exploratory incision which, in many cases, can be carried out under local anesthesia. If a lesion of this important structure is found, it can be remedied, thus returning the patient to work weeks if not months sooner than if a conservative line of treatment had been carried out.

We shall not go into detail about the diagnosis of this lesion other than to emphasize that any time a patient has pain or weakness in the shoulder on abduction of the humerus and a tender point just below the tip of the acromion, one must consider the probability of a lesion of the supraspinatous muscle. One may also palpate, if the patient is not too fat or too muscular, a small sulcus. If, with the pain and weakness, there is an alteration of the scapulohumeral rhythm on movements of abduction or adduction, and if these movements can be performed more easily when the patient is examined in the stooping position with the arm hanging down, the diagnosis offers little difficulty.

#### LESIONS OF THE SERRATUS MAGNUS (ANTERIOR) MUSCLE

Judging by the paucity of the literature on the subject, it would be logical to assume that



injury to the serratus magnus is rare. Fitchet, however, wrote in 1930 that he believed "the scarcity of information about this injury is due not so much to its rarity as to its being overlooked by the examiner."

From the literature we have found only 8 cases of rupture reported: 1 by Morf, in 1874, 1 by Skillern, in 1913, 1 by Lockhart, and 5 by Fitchet, in 1930. Skillern mentioned a contribution by Gower and monograph by Berger, in 1875, which covered many aspects of the subject. He also noted that Hecker, Jobert, and Fuehrer reported patients in whom paralysis followed heavy work that required frequent energetic lifting of the arm. He also added that Weisner attributed the injury in these cases to violent alteration of the entire supraclavicular fossa in shape and position.

The chief function of this muscle is to maintain the scapula against the thorax and to assist in rotating it when the arm is elevated. It is also a powerful aid to inspiration (41). Its antagonists are the rhomboids, the trapezius and the levator scapula muscles. It is innervated by the long thoracic nerve (the posterior thoracic nerve, the long external respiratory nerve of Bell). The different muscles have a complicated action and any "loss of function of any one or more in a large measure might be compensated for by the others" (12).

Rupture of this muscle or paralysis of its nerve prevents the patient from elevating the arm more than 90 degrees. When the arm is held horizontally in front, the scapula, especially its inferior angle and vertebral edge separates from the chest like a door on hinges producing the winged scapula (Fig. 3).

A motor or a muscular lesion may result following a direct or indirect trauma such as a fall, a blow, a compression of the nerve as it traverses the scalenus medius after emerging from its superficial position, or unloading of heavy objects by a short quick shrug of the shoulder. Skillern reported a case of paralysis which occurred in a laborer working at a machine. He was required to reach forward with his arms 800 times during the night. Berkheiser and Shapiro also mentioned inflammation of the nerve as a complication to febrile diseases such as typhoid, influenza, diphtheria or puerperal sepsis. They reported 4 cases of

concussion of the long thoracic nerve, 3 of which followed injury to the shoulder, and 1 of which was associated with the effort of bearing down maneuvers during childbirth.

The patient's complaints are usually weakness, pain, stiffness, lameness, inability to raise his arm higher than the level of his shoulder, and inability to work.

A diagnosis of winged or alar scapula is made easily by inspection. Berkheiser and Shapiro wrote, however, that the difficulty of differentiating between a traumatic rupture of the serratus magnus at its insertion to the scapula and an injury to the long thoracic nerve of Bell is very great because of the inaccessibility of the motor points of the serratus magnus muscle. Many times only the result, that is the amount of return of function, obtained by "immobilization in the position of election for relaxation of the involved muscles," will permit a differentiation between a motor or a muscular lesion. They believe that nerve concussion rather than muscular rupture is the factor directly responsible in these cases which respond to conservative treatment.

The treatment at first should consist in putting the arm at rest in an abducted position, preferably in a cast, with the arm slightly forward. This should be followed later by heat, gentle massage, stimulation by the faradic current, and muscle training exercises.

Berkheiser and Shapiro believe that alar scapula following trauma is more often the result of an injury to the nerve of Bell than to laceration of the serratus magnus. They have obtained complete recovery in 4 cases as late as 18 months after the onset of the paralysis by constant immobilization in a plaster shoulder-pica cast in a position which held the scapula close to the thoracic wall and the serratus magnus muscle relaxed.

Operative procedures should be postponed as a last resort. Skillern has proposed a suture between the proximal end of the short subscapular nerve to the distal end of the long thoracic nerve. Fitchet has suggested that as "the short subscapular nerve is about equal size, of the same origin, and is in close proximity to the long thoracic," the short subscapular might be used.



Fig 1 Case 1 Partial rupture of right deltoid muscle

Others (51) have considered transplantation of muscles, such as the latissimus dorsi over the inferior angle of the scapula, to decrease the deformity, and transplantation of the clavicular origin of the pectoralis major to the serratus magnus or the axillary border of the scapula. The vertebral border of the scapula may be fixed by fascial transplants through drill holes drilled through its border at different points corresponding to transverse processes of the thoracic vertebræ. This would help to stabilize the scapula and somewhat improve the function of the shoulder.

The prognosis should be guarded in such a lesion. If only the muscle is involved and the patient is seen early and proper treatment is instituted, the outlook is favorable for a complete recovery. After that the amount of recovery, as in all shoulder and muscular lesions, is commensurate with the delay in beginning treatment. If the injury involves the nerve primarily, the degree of recovery will depend on several factors, namely, "the early recognition, the extent of the anatomical lesion, the nutritional state of the paralyzed muscle and the extent of the secondary changes in the antagonists." The nerve may be only compressed or contused or the muscle may be severely damaged by lacerations. If this muscle cannot be stimulated to react to the faradic or galvanic currents, no time should be lost in considering surgical intervention, or, in lieu of that, the other muscles of the shoulder girdle should be re-educated to take on some of the function of the disabled serratus magnus.



Fig 2 Case 2 Partial rupture of right deltoid

#### LESIONS OF PECTORALIS MAJOR MUSCLE

As this muscle is an important one in adduction and in internal rotation of the arm, a tear of any size proves very disabling. Such a lesion occurs much more often than one realizes, especially in athletes. Letenneur, in 1861, reported one case, that of a truckman injured when one of the wheels of his truck ran over his shoulder. Letenneur wrote at the time on the facility of healing of subcutaneous ruptures of muscles and tendons and the rapidity of restoration to health, which in certain cases had "made doubtful the existence of the lesion." At that time he stated he did not know of any case of rupture of the pectoralis major having been reported.

This case had unquestionable signs of a direct rupture of the muscle, i.e., swelling of the mammary region, a sulcus between it and the shoulder, inability to adduct the arm, induration and enlargement of the tumor on adduction, and at the point of rupture the anterior wall of the axilla was formed only by skin with no trace of the great pectoral. Leten-

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Fig 3 Case 3 Lesion of right serratus magnus

neur wrote that with conservative treatment this case recovered completely in 15 days with formation of cicatricial tissue at the level of the ruptured muscle

In 1873, Smart reported one case In 1885, Malinowski reported one case This case was one of rupture at its distal attachment to the humerus Mandl in 1923 reported a case which occurred in a gymnast while he was swinging on rings and attempting to rotate his body in its long axis through 360 degrees<sup>1</sup> Mandl found 3 cases reported in the current literature all of which occurred in well developed muscular subjects during the performance of gymnastic exercises

McKelvey in 1928, reported a partial rupture which occurred in a boxer and wrote that to produce such a lesion the muscle must have been contracted violently while on the stretch' He was able to find only 3 cases in the literature

Von Eiselsberg mentioned having seen in the Billroth Clinic a case with a suppurating

hematoma following a partial rupture of the pectoralis major

In 1932, Borchers reported 1 case and found reports of 10 others in the literature He came to the conclusion that tears are not uncommon but that they are often not diagnosed

Pirker, in 1934, also remarked that cases of tears of the pectoralis muscle are seldom found in the literature although this injury occurs occasionally in gymnasts In commenting on a case of rupture reported by Borchers and Tontscheff, which was the result of a direct trauma on a contracted pectoral muscle, Pirker said that the site of rupture is either in the abdominal or in the sternocostal portion, one third of a hand's breadth from the insertion of the humerus, and that seldom does such a tear occur in the muscle attached to the sternum A complete rupture of the origin of this muscle has never been reported

A diagnosis is possible only when in the pectoral region one can elicit a swelling and an indentation which become more pronounced on adduction of the arm against resistance The impairment of function is directly in relation to the extension of the tear Treatment depends on the disturbance of function and may require suture or even a plastic operation

In sharp contrast with these tears and complete ruptures occurring in athletes, Dr C B Horton, of Toronto Canada wrote to us of a lesion occurring in a chronic invalid He said, "an aged imbecile at the Ontario Hospital for the Insane had been completely helpless for years and had to be fed and cared for One morning on going the rounds the attendant reported that this man had a large swelling with an ecchymotic appearance in the region of the left pectoralis major muscle I was not aware of the cause until a day or two after ward when I explored the hematoma with the intention of evacuating the clot and of hastening recovery I found a complete rupture of the pectoralis major with the upper portion drawn into a tense mass at the anterior border of the axilla and the lower portion forming a raised edge along the costal origin of the muscle It is my present recollection that the clavicular portion of the muscle was unaffected There was no history of injury, and



Fig 4 Case 4 Complete rupture of the mid-portion of the right coracobrachialis muscle. The rupture is made conspicuous by the extreme internal rotation of the arm

the rupture evidently occurred while the patient was in bed "

Moulonguet, in 1924, also reported a case of spontaneous rupture of the great pectoralis muscle in a man 72 years old. He interpreted the rupture as due to senility, probably produced by a sudden change of temperature from an overheated place to cold and humid air. An autopsy performed 3 weeks after the rupture revealed a large hematoma in the pectoral region containing one quart of blood. The ends of the great pectoral were torn, shredded, and free in the cavity occupied by the hematoma. Microscopic examination revealed granular disintegration. He concluded that in a review of the literature an infectious myositis or a dystrophic one (such as in scurvy) was mentioned as the cause of pathological muscular rupture. This observation proved that senile alterations of muscle are susceptible of being complicated by a spontaneous rupture with abundant hemorrhage.

#### RUPTURE OF SUBSCAPULARIS MUSCLE

This muscle is an important one of the shoulder girdle and acts especially as an internal rotator and adductor of the humerus, and as a forward flexor at the shoulder joint. It forms the greater part of the posterior wall of the axilla and at its attachment to the lesser tuberosity of the humerus its tendon blends into the musculotendinous cuff where it fuses with the short rotators of the humerus and the capsule of the joint.

In a review of the literature we have been unable to find any case of rupture of this mus-

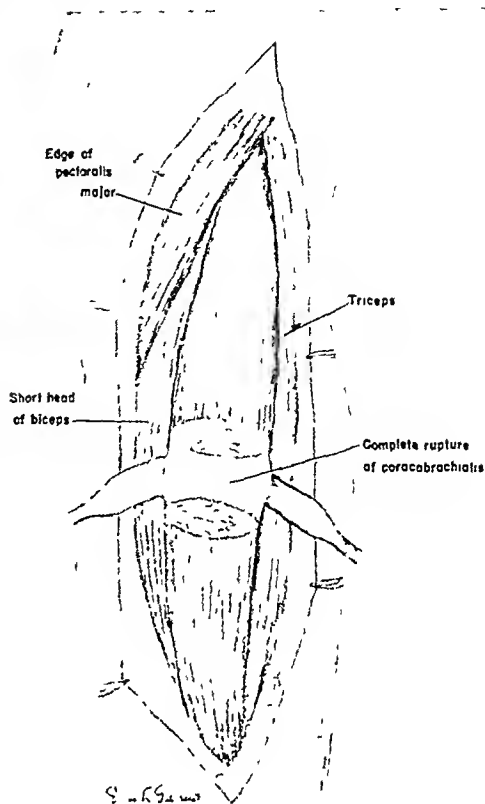


Fig 5 Case 4 Schematic drawing of condition found at operation of rupture of coracobrachialis

cle. In a personal communication, Dr Kellogg Speed has informed us of 2 patients in whom he made diagnoses of ruptures of the subscapularis tendon but they did not come to operation. Dr Bull and Dr Gilbert have had 1 patient in whom the rupture was found at operation. This was a very interesting case because of the length and degree of disability, the localized symptoms, the objective, and the operative findings.

#### RUPTURE OF CORACOBRACHIALIS MUSCLE

We have been unable to find any cases reported in the literature. We can report one case which was due to direct violence. Early operation resulted in a complete recovery which would not have occurred otherwise as there was a large rupture in the belly of the muscle (Figs 4 and 5). The patient did not have much pain but complained of consider-



Fig 6 Case 5 Rupture of left triceps before operation  
Fig 7 Case 5 Postoperative result showing line and extent of incision and absence of former bulging of triceps.

able impairment of the function of his arm. Although some may consider this muscle as an unimportant or even a rudimentary one, the action of which is to assist the biceps as an adductor and flexor of the humerus the muscle in this patient was large and well developed.

#### RUPTURE OF THE TRICEPS MUSCLE

Rupture of the triceps muscle is an uncommon injury. We have been able to collect only 10 cases in the literature. Cases have been reported as follows: Partridge, 1 in 1868; Gueterbock, 1 in 1881; Bilhaut, 1 in 1903 (he considered it a case of muscular hernia with rupture of the aponeurosis, but from his description of the case it must have been one of extensive partial muscular rupture); Schiack, Cottbus, 1 in 1908 and also 6 collected from the literature; Penhallow, 1 in 1910; Strohmeyer, 1 in 1917; Montgomery, 1 in 1920; Cassirer, 1 in 1922, and Hackenbrock, 1 in

1922. Fasiani, in 1923 reported 1 case which was treated conservatively. All but 1 of the cases were the result of direct violence. We have 3 additional cases to report. We operated upon one of these patients (Figs 9 and 10). For 2 of these cases we are indebted to Dr L. L. Stanley, of San Quentin Prison, and for the third to Dr R. L. Waugh of the United States Marine Hospital in New Orleans.

A tear of any size in the triceps muscle considerably impairs the power of extension of the elbow. There is usually moderate swelling and the interruption of the tendon will permit palpation of the margins of the olecranon and of the humerus. Early exploration and repair usually achieves a complete restoration.

#### RUPTURE OF THE BICEPS MUSCLE

Lesions of this muscle and tendon have interested one of us (15) for the past 14 years and its various manifestations have been discussed by him in 4 previous articles in one of which 100 cases were analyzed (17). For a complete clinical account therefore the reader is referred to them. For a graphic account of anatomical observations the reader is referred to the various articles by Meyer (32, 33). He has had well over 1,000 shoulders dissected in his laboratory and it has been our great privilege on numerous occasions to examine these interesting specimens with him.

When these shoulders are opened one observes that there has been a destruction from within, that is extra articular rather than intra articular. One sees a fraying of the under surface of the deltoid muscle, considerable wear in the superior part of the floor of the subdeltoid bursa, a circular defect in the ten-



Fig 8 Rupture of right biceps<sup>1</sup>

Kindness of Dr R. L. Waugh of the U. S. Marine Hospital in New Orleans



Fig 9 Rupture of triceps brachii in an elderly man<sup>1</sup>

<sup>1</sup>Courtesy of Dr L. L. Stanley, San Quentin

don of the supraspinatus, erosion and sometimes complete destruction of the tendon of the biceps, large defects in the humeroscapular articulation, etc. None of the changes noted was, in any sense, inflammatory in nature. When the capsule was opened, there was no collection of fluid or pus nor the slightest evidence of arthritis.

Reviewing his specimens, Meyer was impressed further by finding early defects in the capsule near its attachment to the greater tuberosity. He reasoned that these capsular defects resulted "from repeated and long continued use of the arm in a position of marked abduction and external rotation." These observations naturally led him "to consider the possibility of an occupational cause." He concluded that the incidence of spontaneous destruction and dislocation of this tendon must be exceedingly common in laborers working in lumber and construction camps and in mines. A sudden trauma in such cases, therefore, would be only the immediate cause. Physicians and surgeons in general have been slow in appreciating the wide clinical significance of Meyer's epoch-making discoveries which were first brought to our attention in 1915.

While attrition due to occupation will, undoubtedly, explain many lesions of the tendon, one must bear in mind other causes such as the degenerative changes due to senility, arthritis, myositis, arteriosclerosis, acute and chronic infectious diseases, fatigue, and trauma. We have seen however, a number of lesions which occurred in young, healthy, and robust

men while they were engaged in games to which they were accustomed, such as handball, football, and bowling. In these patients it is very important to make an early diagnosis and to repair the lesion to obtain a complete restoration of function (Figs 10 and 11).

The surgical approach for the repair of disinsertion of the proximal end of the tendon of the long biceps, which we have used recently, consists in extending the incision up over the anterior portion of the shoulder and, instead of retracting and cutting the lower portion of the great pectoral muscle, the fibers over the coracoid process are separated. In this manner the upper and detached end of the long biceps can easily be brought up and sutured to the coracoid process and to the tendon of the short head.

*Elongation of the tendon of the long biceps*  
This lesion may arise from many causes, which have been discussed by one of the authors in a previous article (18). He has used various methods for shortening the tendon, and thereby brought up the belly of the muscle to its proper place. Not only is a gratifying cosmetic result obtained but the function of the arm is much improved (Figs 12, 13, and 14).

*Dislocation of the tendon of the long biceps*  
This condition has proved, heretofore, to be very baffling. Although 71 cases have been recorded as having been seen clinically since the first article by Cowper in 1724, and many cases found at autopsy have been recorded, and even though Meyer has observed over 50 cases of marked dislocation and many others



Fig 10 Case 7 Before operation. Disinsertion of tendon of right long biceps from lip of glenoid in a ten-pin bowler. Note lowering and bulging of the belly of long biceps.



Fig 11 Case 7 After operation. Note that the contour of the region of the biceps has been restored.





Fig 12 Case 8 Before operation. Elongation of tendon. Note besides the characteristic bulging of belly the widening and deepening of hollow between deltoid and belly of long head of right biceps.



Fig 14 Case 8 A few weeks after operation. Note the perfect re-establishment of muscle balance and the restoration of contour.

of lesser degree in the dissection of 1000 shoulders no patient had been operated upon for the relief of this condition until in recent years (Figs 15 and 16). One of the authors operated upon such a patient in 1926 and analyzed 6 cases (18), 2 of these patients having been operated on by Dr Edward C Bull. Dr Abbott and Dr Saunders presented a paper on this subject before the California Medical Association in 1934 and recorded, I believe, 3 operative cases.

The symptoms of this condition depend on the degree of dislocation. The onset is usually acute. The symptoms may not be very pronounced at first and many of the objective signs may be obscured by the tenosynovitis and generalized soreness which result from the production of such a lesion. We have worked out a simple and useful diagnostic test which is fully described elsewhere (17). Surgical repair will give an excellent result.

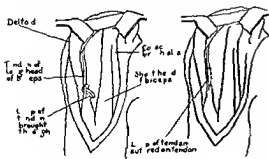


Fig 13 Case 8 Author's method of shortening tendon and thereby securing a muscle balance with short head.

#### REPORT OF CASES

CASE 1<sup>st</sup> A B a man aged 27 years was injured while lifting a heavy box from the ground to a place above his head. He felt a sudden snap in the upper right arm and noticed a large lump which gradually increased.

**Examination.** Eight months after the accident there was a large and indurated mass in the region of the deltoid muscle. Movements of the arm were painless and complete but the power of abduction in the affected arm was impaired. There was a definite hiatus just above the insertion of the deltoid where the fibers evidently had been avulsed upward. Past history was essentially negative. Patient declined to have an operation.

CASE 2<sup>nd</sup> A H a man aged 21 years, was injured August 14, 1934 while driving an automobile. Another car drove into him and as a result of the collision he received an injury to the right shoulder. Following the accident he was taken to the Berkeley General Hospital where he remained 3½ days. He stayed at home then in bed for 6 days. He had pain in his right shoulder when he attempted to use it strenuously and the power of abduction was considerably reduced in his right shoulder.

**Examination.** He was able to put his right arm through a normal range of motion. The power in the right arm was reduced in performing the motion of abduction to about one half of that in the left arm. Examination of the right deltoid muscle showed a marked irregularity in this muscle. The posterior half of the muscle apparently had been torn loose from its insertion and was retracted upwards a distance of about 2 inches. This caused the posterior half of the muscle to bulge unduly when it was contracted. The patient declined an operation.

CASE 3<sup>rd</sup> W L G a man aged 63 was injured March 14, 1934 when after lifting a heavy stone

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Fig 15 Left, A dissection made in the anatomical laboratory of Dr A W Meyer of Stanford University "The left shoulder showing the long tendon practically unaffected and displaced anteriorly or ventrally, in order to reveal the position in which it lay The arrow points to the supratubercular ridge This tendon is never dislocated distal to the ridge A little proximal from the supratubercular ridge can be seen the capsular sling on which this tendon played and which protected it from wear underneath, a small portion of the cartilage of the head of the humerus is revealed immediately proximal to it "

Fig 16 Same as Figure 15 "The left humerus showing the distal portion of the long tendon *in situ*, and with a bifurcated attachment extending toward both the tuberosities However, the tendon is also attached in the floor of the sulcus, and the great widening of the proximal portion of the sulcus shows that this tendon was maximally dislocated before it was divided Some osteophytic reaction is evident in the intertubercular region of the sulcus and proximal to this region "

he tried to throw it forward into a truck Instantly he felt a sudden twinge of pain in the region of his right scapula From that time he had an ache and a feeling of lameness in his shoulder and a few days later his wife called his attention to "a winging out of his shoulder blade "

**Examination** On inspection April 21, 1934, one could see a moderate drooping of the right shoulder, the acromion being conspicuously lower on the right than on the left side When viewed from the side, with his arm hanging at rest, his right scapula projected from the chest When viewed from the rear with the arms raised his scapula assumed the classical angel-winged position On palpation there was moderate tenderness on pressure over the vertebral border of the right scapula Electrical reactions were normal to galvanism in so far as reversal of the poles was concerned, but faradic irritability was reduced over the right serratus muscle

**Diagnosis** This evidently was a traumatic paralysis of the right serratus muscle due to injury of the long thoracic nerve

**Result** The patient was unable to remain for treatment He declined operation

**CASE 4** E R B, a man, aged 33, was injured on June 30, 1934, while helping to operate a charging machine He had his right arm extended forward and downward and was holding on to the shoe of the machine so that his arm was tense When the machine went backward his arm followed outward until it became caught against a stanchion Instantly he felt a heavy pressure on the internal aspect of the right arm, near the axilla He shouted, and the machine was immediately reversed, thereby freeing his arm He swung his arm around to ascertain if it was hurt and then he noticed a depression in it although he felt little pain The next day his arm was sore and felt weak when he attempted to pull anything toward him or to pull his arm towards his body (adduct to median line) He said that on flexing his arm, it felt weak at the beginning of flexion until one-third of the way In adduction to mid-line the arm was weak all the way Since the day following the accident he had had only a slight soreness and a

sort of catch in the region where the indentation was whenever he used his arm. This region had also been tender to touch.

**Examination.** On July 2 1934 there was a slight erythema over the upper third of the right arm but no abrasion of skin and very little if any swelling. With his right arm abducted an indentation or hiatus was clearly visible in the lower portion of the upper third between the short head of the biceps and the triceps. When the arm was rotated as far internally as possible and the patient was told to make a strong grip the depression became more pronounced and on palpation one felt a distinct diastasis and this area was tender. There was no evidence of injury to either the long head or short head of the biceps or to the triceps.

**Operation and result.** On July 15 1934, under local anesthesia of one half per cent novocain an incision of 15 centimeters in length was made over the border of the right pectoral muscle extending down the inner aspect of the right arm and exposing the muscles in this region. The edge of the pectoralis major short head of the biceps coracobrachialis and the triceps muscles were exposed and brought into view. When the patient was requested to contract his arm nothing abnormal was seen but when he flexed and adducted his arm a hiatus was seen in the mid portion of the coracobrachialis muscle. This muscle was covered by a sheath and no rupture was visible although a definite depression could be seen and felt with the finger. The muscle sheath then was opened and a complete rupture of the mid portion of this muscle was found.

Each half of the muscle belly which was about the size of a lemon cut transversely had separated for about an inch. There was no hematoma present and only 1 or 2 minute blood clots. The forearm was flexed and the arm lifted and adducted in the position of putting the right hand over the left shoulder. This brought the 2 halves of the ruptured muscle without tension into complete apposition. They were approximated by 3 interrupted sutures of No. 2 chromic catgut reinforced by 4 fascial strips secured from the right thigh.

The wound of the arm was closed in layers without drainage. The operation was performed mostly under local anesthesia to achieve a complete repair under voluntary control of his muscles and was finished under gas. The arm was immobilized in a Velpeau bandage to the chest leaving the coracobrachialis muscle in complete relaxation that is having the right arm forward over the chest with the right hand near the left shoulder. After operation the patient obtained a good functional result.

**CASE 5.** J. J. aged 23 was injured in 1931 when he was in an automobile accident. While under the influence of liquor he was driving with his left arm resting on the window sill. He failed to negotiate a turn and collided with an iron post hitting the left forearm and elbow. He was removed to a hospital

and treated for a fractured left elbow for 2 days. His whole left arm from the wrist to the shoulder was badly swollen. He could not get his arm in the sleeve of his shirt bend the arm or move his fingers.

The swelling subsided in 2 weeks when he noticed a big lump on the undersurface of the upper left arm which had persisted without apparent diminution in size. He had fairly good function in the left arm but stated that he had not so much strength in that arm as in the right one. This was especially noticeable when he attempted lifting.

**Examination.** There was a bulging tumor mass in the upper third of the posterior or extensor surface of the left arm. On palpation it was readily discernible that the tumor consisted of a contraction of the muscular belly of the triceps muscle.

**Operation and result.** On May 20 1936 under general anesthesia a linear incision 12 centimeters in length was made over the mid portion and lower end of the left triceps and carried up exposing the belly of the triceps muscle which was found to be contracted and bulging. The muscular portion of the long head of the triceps had torn loose from the tendinous portion of the lower end. The muscular portion of course was found to be adherent to all the surrounding tissues. These adhesions were liberated with the finger and by sharp dissection with the scalpel. Then by slow traction on the muscle it was possible to lengthen it gradually without tearing until its normal length was practically reestablished.

The repair was carried out in this manner. By 6 mattress sutures the lower end of the muscle was sutured to the tendinous portion. It was also found that a portion of the lower end of the external head of the triceps was torn and after liberating this, the muscular end was brought through the lower end of the tendon by incising the tendon and pulling through the lower end of the muscle. By interrupted sutures as a further method of fortification the fascia over the belly of the muscle was sutured over the musculotendinous portion giving a firm fixation. With this accomplished it appeared as if a complete reestablishment of the large rupture of the triceps had been accomplished. The wound was sutured in layers and the arm immobilized in extension. The patient received a good functional result.

**CASE 6.** D. L. G. a man aged 30 was injured in September 1935. He was carrying a steel cable choker weighing 70 pounds and threw it over some brush with his right hand. A hook caught on the glove of his left hand and the spring of the coiled cable jerked and twisted the relaxed arm which was extended by the jerk. There was immediate pain and disability in the left shoulder and arm. The pain radiated to the left side of the neck and chest. He then consulted a physician who immobilized the arm and prescribed heat and massage. After several weeks treatment he began to try using the arm but felt a catching grating and clicking sensation especially when arm was in a position of abduction.

*Examination* On April 23, 1936, there was only moderate atrophy of the muscles of the left shoulder. The movements were restricted, especially abduction (70/180) and forward rotation (80/180) with pain at the limit of the range of motion. External rotation of the humerus caused loud, multiple, snapping sounds, associated with pain, which felt as if it were produced by a tendon or a thickened mass of soft tissue passing over the tip of the greater tuberosity under some tension or compression. About 1 out of 3 times when he carried out this movement a loud sharp snap was heard as if a definite structure, like the biceps tendon, might be slipping over a bony prominence while under some tension. It was this repetition of movements which produced those snapping sensations which caused his shoulder to become sore in a short time. As this developed the disability in his shoulder became very marked. The supraspinatus muscle was not tender, apparently was not atrophied, and appeared to be used very much like its mate in the uninjured shoulder. Tension on the biceps muscle seemed to make no difference in the manner in which he performed his movements or in the degree of discomfort felt. This suggested that the snapping sound was produced by some other mechanism than an abnormally movable bicipit tendon. The patient moved his shoulder quite willingly but guarded the movements carefully as the painful point was approached, seeming to have actual pain and wincing with each of the multiple snaps produced by movement. Roentgen examination revealed an irregular area of bone absorption just below the level of the greater tuberosity.

*Diagnosis* Probable partial tear of one of the muscular insertions about the greater tuberosity of the humerus.

*Operation and result* On April 27, 1936, under general anesthesia an incision was made along the anterior margin of the deltoid muscle and carried down exposing the joint structures. It was readily seen that there had been an extensive tear of the tendon of the subscapularis muscle near its insertion on the humerus. The muscle appeared to have been torn transversely a distance of about an inch, the tear extending backward from the anterior margin of the tendon parallel to the joint margin and about one-half or three-fourths of an inch from the insertion on the humerus. The tear had extended also proximally between the supraspinatus and subscapularis for a distance of probably  $1\frac{1}{2}$  to 2 inches. This had created a defect in the fibrous capsule of the shoulder joint which had filled in with very inadequate and thin scar tissue, and at this point the capsule was very loose and would probably have permitted dislocation of the shoulder on slight provocation if the patient's discomfort had allowed him to abduct the arm freely. There was also a loose flap of fibrous and synovial tissue hanging free from the joint lining for a distance of an inch or more. This flap was one-half or three-fourths of an inch from the articular margin and about five-eighths of an inch wide. Its structure was rather dense and it seemed likely

that the clicking and snapping sensation observed on examination of the patient was due to movements of this loose flap. The torn subscapularis tendon had retracted considerably, but the margin of the tendon was freed along the general line of the original tear and it was drawn as near as possible to its original position and sutured in place with interrupted chromic catgut sutures. The loose fibrous capsule of the shoulder joint was partially excised and the freshened margins of the subscapularis and supraspinatus tendons were sutured together as closely as possible in an attempt to restore normal strength in this part of the shoulder joint capsule. The patient's arm was bandaged to his side in a position of internal rotation with the elbow forward on the chest to relax the sutured muscle.

*Result.* He secured a satisfactory result and returned to his regular work.

*CASE 7* J. O., a man, aged 52, was injured on May 5, 1935, while playing in a bowling tournament. He raised his right arm above his head in the usual manner and had gripped in his hand a bowling ball, weighing 15 pounds 13 ounces. The regulation weight of a bowling ball is 16 pounds. This was 3 ounces less, and was the weight of the ball he used all the time. He said he made no more strenuous effort than he had made thousands of times. Just as he threw the ball he heard and felt something tear in his right arm in the region of the biceps muscle. Then he picked up a second ball and threw that. As he did this he had the sensation of someone putting a knife in his elbow and ripping it up to his shoulder. Then he took a third ball and as he started to throw it he gripped it and it fell right out of his hand. After this he became sick to his stomach and his arm felt weak. He lay down for 15 or 20 minutes in a cold perspiration. A doctor was called, who came to the bowling alley to see him, and wrapped his arm and told him he had torn a muscle. His arm caused him no pain when it was at rest, but when he tried to lift anything he found it difficult to raise it more than a few inches, and he had a feeling of soreness and a sharp pain, cutting in character, in the biceps muscle.

*Examination* May 8, 1935, there was an area of ecchymosis over the proximal end of the right biceps. The belly of the biceps had dropped down so that when the arms were held in extension the hiatus between the deltoid and the biceps was very conspicuous, measuring in the left arm 1 finger's breadth, and in the right arm 3 fingers' breadth. With arms hung to the sides in a natural position with the palm forward one could see that the belly of the biceps had dropped down and there was a hollow above the biceps.

*Operation and result* On May 10, 1935, under local anesthesia an incision was made over the tendon of the long head of the biceps and carried down exposing the tendon which was found ruptured near its upper end. The tendon had gone down toward the muscle but had not turned over. It was freed and brought out and seen to be long enough to put up to the coracoid process. As the pectoral muscle was so

well developed it was impossible to retract it sufficiently to get a good fixation of the tendon of the long head of the biceps on the coracoid process. Therefore the fibers of this muscle were split with the fingers and separated so that the coracoid process was visualized easily which gave adequate space for the tendon to be brought up underneath this muscle and the fixation could be performed readily. The fibers of the tendon of the short head of the biceps were then separated at the level of the coracoid process and the tendon of the long head of the biceps was pushed through the opening. Then the proximal end of the long head of the tendon was sutured to the coracoid process and reinforced by suturing to each side of the tendon of the short head of the biceps through which it had been inserted. Silk sutures were used throughout. The muscles were then approximated loosely with No. 1 catgut and the wound closed in layers. The operation was done under local anesthesia and the patient stood it well. The arm was put up in a Velpau bandage.

**Result.** On June 8, 1935, result was most satisfactory. On July 15 he returned to his regular work.

**CASE 8.** C. H., a man aged 35 years, was injured June, 1925, when he was thrown from a truck which turned over pinning him underneath. While making an effort to free himself he felt a slight snap in the right shoulder. After hearing the snap in his shoulder he felt a very severe pain there and then became unconscious. In this accident he suffered a fracture of the occiput and a dislocated vertebra.

**Examination.** On April 17, 1938 (Fig. 12) it was revealed that the belly of the long head of the right biceps was definitely smaller than the left and on flexion the belly bulged and this bulging was about 2 fingers breadth lower down the arm than the muscle of the long head of the other arm. This arm was seen readily to be weaker than the other.

**Operation and results.** On April 17, 1938, under general anesthesia an incision was made from the shoulder extending from along the insertion of the pectoralis major over the biceps. The 2 muscles of the biceps were then exposed and separated from each other. The muscle and tendon of the short head were normal. The muscle of the long head had retracted and the tendon had become attenuated but was not seen to be ruptured. The tendon was pulled up and shortened about 2 centimeters and then the loop of the tendon was pulled through an opening in the muscle at the beginning of the tendon (Fig. 13). This shortened the tendon about 2 centimeters and brought the bellies of the long head and the short head side by side. This man secured a very satisfactory and useful arm. The contour of the muscles became practically normal (Fig. 14).

#### SUMMARY

No surgeon ever sees many ruptures of the various muscles of the shoulder.

(The authors are indebted to Dr. L. L. Stacey of the California State Prison at San Quentin for permission to examine and operate upon this patient.)

A review of the literature revealed that with the exception of many cases of supraspinatus and biceps, a surprisingly few cases of the other muscles and tendons of the shoulder girdle and upper arm have been reported. We have found only 1 uncomplicated rupture of the deltoid, 8 of the serratus magnus (anterior), 8 of the pectoralis major, none of the subscapularis, none of the coracobrachialis and 10 of the triceps.

The rôle of acute trauma, direct or indirect, is greater than all other causes of shoulder disability, including senility, disease, fatigue and attrition.

The most frequent mechanism producing a partial or complete rupture of a muscle or a tendon is the sudden application of a stretching force to a muscle which is in the process of vigorous contraction.

A tear in a muscle or tendon about shoulder joint or upper arm will produce pain in the joint and often cause an incorrect diagnosis.

A careful history and examination usually will lead to an early diagnosis.

Treatment should be directed to prevent contracture and atrophy of the muscles of the shoulder girdle.

Prompt surgical intervention and repair of the tears in the muscles and tendons about the shoulder in the majority of the patients will give satisfactory results.

#### BIBLIOGRAPHY

1. BERKEHEISLA, L. J. and STAPARO, T. A traumatic palsy of serratus magnus. *J. Am. M. A.* 1937 109: 1790-1793.
2. BURKART, W. Rupture de l'aponévrose du muscle triceps brachial: hernie musculaire. *Ann. de chir. et d'orthop.* 1903 16: 353-357.
3. BONCHERS, E. and TONTSCHKE, P. Die subkutane Ruptur des grossen Brustmuskels: ein wenig bekanntes aber typisches Krankheitsbild. *Zentralbl. f. Chir.* 1932 59: 770-774.
4. BILL, EDWARD C. and GILBERT, RANDY. Personal communication, 1938.
5. BLUES, F. E. Nerve injuries about the shoulder joint. *Tr. Am. Surg. Ass.* 1903 21: 521-562.
6. CASSARA, R. Ueber die Wirkung der Triceps Brachii. *Monatsschr. f. Psychiat. u. Neurol. Berl.* 1922 52: 1-5.
7. CLEMENS, H. *Traumatische Hernie des Deltoides*. Deutsche med. Wchn. chr. 1913 39: 2197.
8. COOMAN, F. A. The Shoulder—Rupture of Supraspinatus Tendon and Other Lesions in or about the Subacromial Bursa. Boston: Thomas Todd Company Printers, 1934.
9. COLES, W. P. Rupture of pectoralis minor. *Boston M. & S. J.* 1920 182: 200.

- 10 CUNNINGHAM, D J Text Book of Anatomy, 2nd ed New York William Wood & Company, 1925
- 11 DAVIS, C B Plastic repair of the deltoid muscle Surg Clin, Chicago, 1919, 3 287-289
- 12 ESHNER, A A Three cases of paralysis of the serratus magnus and the trapezius alar scapula J Am M Ass, 1902, 38 300-306
- 13 FASIANI, G M Su di un caso di rottura sottocutanea contemporanea di tre tendini Riforma Med, 1923, 39 557-559
- 14 FITCHER, S M Injury to serratus magnus (anterior) muscle New England J Med, 1930, 203 818-823
- 15 GILCREEST, EDGAR L Rupture of muscles and tendons, particularly subcutaneous rupture of biceps flexor cubiti J Am M Ass, 1925, 84 1819-1822
- 16 Idem Two cases of spontaneous rupture of the long head of the biceps flexor cubiti Surg Clin N America, 1926, 6 539-554
- 17 Idem The common syndrome of rupture, dislocation and elongation of the long head of the biceps brachii Surg, Gynec & Obst, 1934, 58 322-339
- 18 Idem Dislocation and elongation of the long head of the biceps brachii Ann Surg, 1936, 104 118-138
- 19 GUETERBOCK, P ZerreiBung des Sehne des M Triceps Brachii Arch f klin Chir, Berl, 1881, 26 259
- 20 HACKENBROCK, M Ueber einen Fall von Subkutaner Rupture des dreiköpfigen Oberarmmuskels Monatschr f Unfallheilk, Leipzig, 1922, 29 85-88
- 21 HORTON, C B Personal communication, 1925
- 22 LEMPERG, F A Zur Erleichterung der Deltoideusplastik Zentralbl f Chir, 1922, 49 1108-1111
- 23 LETENNEUR, M Rupture souscutanée du muscle grand pectoral, guérison complete en quinze jours J d la Sect de méd Soc Ac Loire Inf N S Nantes, 1861, 37 202-205
- 24 LOCKHART, R D Movement of the normal shoulder joint and a case with trapezius paralysis studied by radiograms and experiment on the living J Anat, 1930, 64 288-302
- 25 LOVETT, R W The diagnosis and treatment of some common injuries of the shoulder joint Surg, Gynec & Obst, 1922, 34 437
- 26 MALINOVSKI, I Rare case of rupture of the pectoralis major at its attachment with process of humerus Voenno-Med J, S-Peterb, 1885, 153 136-138
- 27 MANDL, F Ruptur des Musculus Pect Major Wien med Wchnsch, 1925, 75 2192
- 28 MAYER, LEO Rupture of the supraspinatus tendon J Bone & Joint Surg, 1937, 19 640-643
- 29 MCKILVEY, D Subcutaneous rupture of pectoralis major muscle Brit M J, Lond, 1928, 2 6-11
- 30 MEYER, A W Unrecognized occupational destruction of the tendon of the long head of the biceps brachii Arch Surg, 1921, 2 130-144
- 31 Idem Spontaneous dislocation of the tendon of the long head of the biceps brachii Report of four cases Arch Surg, 1926, 13 109-119
- 32 Idem Spontaneous dislocation and destruction of tendon of the long head of biceps brachii Fifty-nine instances Arch Surg, 1928, 17 493-506
- 33 Idem Chronic functional lesions of the shoulder Arch Surg, 1937, 35 646-674
- 34 Idem Personal communications, 1937 and 1938
- 35 MONTGOMERY, A H Two cases of muscle injury, one a rupture of the biceps and the other a rupture of the triceps Surg Clin, Chicago, 1920, 4 871-877
- 36 MORE, J Ein Fall von ZerreiBung des Serratus anticus major Aerztl Int Bl, Muenchen, 1874, 21 113
- 37 MOULONGUET, G Rupture spontanée du grand pectoral chez un Vieillard, énorme hematome mort Bull et mém Soc anat de Par, 1924, 94 24-28
- 38 PARTIDGE, RICHARD A case of rupture of the tendon of the triceps cubiti Med Times & Hosp Gaz, Lond, 1868, 1 175
- 39 PENHALLOW, D P Report of a case of ruptured triceps due to direct violence New York M J, 1910, 91 76
- 40 PIRNER, HERBERT Die Verletzung der durch Muskel zug Erghn d Chir u Orthop, Berl, 1934, 27 553-634
- 41 POIRIER, P, and CHARPY, A Traité d'anatomie humaine Paris Masson et Cie, Edit, 1912
- 42 SCHLIACK-COTTBUS, C Ein Fall von subkutaner Durchreissung des Musculus Triceps Brachii durch direkte Gewalt Monatschr f Unfallheilk, Leipzig, 1908, 15 331-333
- 43 SHERREN, JAMES Injuries of Nerves and Their Treatment Longon J Nisbet & Co, 1908
- 44 SKILLERN, PENN J Serratus magnus palsy (with proposal of a new operation for intractable cases) Ann Surg, 1913, 57 909-915
- 45 SMART, A Rupture of pectoralis major Guy's Hosp Gaz, Lond, 1873, 2 61
- 46 SMITH, J F, and CHRISTENSEN, H H Deltoid paralysis following shoulder injuries Surg, Gynec & Obst, 1925, 41 451-453
- 47 SPEED, KELLOGG Personal communication, 1938
- 48 STANLEY, L L Personal communication, 1937
- 49 STROMEYER, K Erstaz der triceps-sehne durch freitransplantierte Faszie Muenchen med Wchnsch, 1917, 64 825
- 50 TEES, F J Suture of the circumflex nerve Canadian M Ass J, 1921, 11 46
- 51 THOMSON, ALEXIS, and MILES, ALEXANDER Manual of Surgery Winged Scapula, 4th ed, vol 2, p 881 New York Oxford University Press, 1912
- 52 WAUGH, R L Personal communications, 1937 and 1938

# CLINICAL SURGERY

FROM THE GLASGOW ROYAL INFIRMARY

## SUPRAPUBIC PROSTATECTOMY

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**R**EMOVAL of the prostate by the suprapubic route is the procedure preferred by the writer on all patients whose obstructive symptoms are due to prostates of the large adenomatous type. Transurethral resection is the method favored for the smaller types of glandular obstructions and for carcinoma. Suprapubic cystotomy is reserved for those who are unfit for either procedure. Out of a total of 106 patients operated upon for prostatic obstruction in 1937 a suprapubic prostatectomy was carried out on 50 or 47 per cent. A two stage operation was performed on 12 of these patients.

The technique of suprapubic prostatectomy now used by me has been arrived at after extensive experience with the operative methods used by Freyer, Thomson, Walker, Bentley, Squier and Harris. The various steps are based on the work of these great pioneers in this branch of surgery.

### POSSIBLE DANGERS AND COMPLICATIONS

Failure of the cardiovascular system to stand up under the strain of the operation, postoperative pulmonary complications including embolus, renal failure and urinary sepsis are the dangers and complications to be feared and guarded against. Methods to avoid the two latter conditions will be dealt with in subsequent paragraphs. With regard to the cardiovascular system I think it is correct to say that the majority of prostatic patients exhibit degenerative vascular changes and varying degrees of weakness of the cardiac musculature. A thorough medical overhauling should therefore be a routine practice. It is difficult however even for an expert physician to determine the exact degree of cardiac reserve in any given case. In patients with a recognizable impairment rest in bed with appropriate treatment of the heart, combined with drainage of the

bladder may result in such a degree of improvement that operation can be carried out. If sufficient improvement does not occur, one can not proceed with major operative intervention. To lessen the risk of postanesthetic pulmonary complications, cyclopropane or gas and oxygen with a minimum of ether are the anesthetics usually preferred. At the termination of the operation respiratory activity is stimulated by carbon dioxide inhalation. The patient is slightly elevated on pillows as soon as he is out of the anesthetic. The degree of elevation is gradually increased and within 24 hours he is usually well enough to be in a sitting position. He is encouraged to move his lower limbs about in bed at frequent intervals and is allowed out of bed at the earliest possible date.

### PRE-OPERATIVE INVESTIGATION AND PREPARATION OF THE URINARY TRACT

A satisfactory renal function is a *sine qua non* before operation is decided on. The existence of marked impairment is usually recognizable by obvious clinical manifestations such as a dry skin, loss of appetite, indigestion, and constipation. Persistent thirst, a dry mouth and a furred tongue are ominous signs. As an aid to the recognition of the lesser degrees of renal impairment the routine biochemical tests which are relied on are an estimation of the blood urea and the urea concentration test. If the blood urea is higher than 50 milligrams per cent the renal condition is regarded as unsatisfactory. A reading below this figure is not however considered by itself to indicate a good renal function. Chief reliance for this information is placed on the urine urea concentration test. The patient is given 15 grams of urea dissolved in 100 cubic centimeters of water and the percentage of the urea found in the urine during the first, second and third hours is estimated. If the patient is not on bladder drainage by an indwelling urethral catheter one is usually inserted for the period of the test. The quantity

The illustrations for this article were all drawn by Miss C. Brown Kelly. Figures 6 and 7 are based on illustrations in the paper by the late Mr. Harry Harris published in the *British Journal of Surgery* in January 1931 and as acknowledged in the text. Figure 3 is a replica of a drawing in the same paper.

of urine passed in each hour is noted and the percentage of urea excreted in each specimen is estimated. The total amount of urea eliminated in each hour is thus calculated and should in the second hour be not less than 15 grams, i.e., one tenth of the amount swallowed.

As a check-up on the above tests, the indigo-carmin test is frequently used. An intravenous injection of 8 cubic centimeters of a 0.4 per cent solution is given. A good blue coloration should appear in the urine within 10 minutes.

If these tests indicate a renal insufficiency, treatment must be carried out with a view to its correction before operation. Forced diuresis and continuous bladder drainage are the methods used to achieve this objective. The patient is encouraged to drink as much fluid as possible, aiming at a minimum of 5 pints per day. A soft rubber catheter is retained in the urethra and connected by a glass connection to a length of rubber tubing, which drains into a bottle containing a measured quantity of antiseptic at the side of the bed. The bladder is washed out once or twice a day depending on the degree of urinary infection present. Two to 3 pints of 1:10,000 silver nitrate solution are used for each wash out. For very dirty bladders the routine recommended by Harris has been found useful. It is as follows: A solution of potassium permanganate of a light pink color is washed backward and forward through the catheter until the return fluid is clear. The remainder is then washed out with plain sterile water. Four ounces of 1:3,000 solution of nitrate of silver are then injected into the bladder and the catheter is clamped for half an hour if the patient will tolerate it for that time. Then it is connected to bottle at the bedside.

Throughout the period of preparation the urine is kept acid by acid sodium phosphate, 10 grains three times daily. If a stronger acidifier is required, ammonium chloride, 15 grains in capsules, 3 to 4 times daily, is substituted. As long as the urine is acid, hexamine in doses of 10 grains thrice daily is also given.

For a patient whose renal impairment is not marked, catheter drainage for a week or 10 days will usually suffice. For a patient with a good renal function, I see no advantage in draining the bladder for more than 4 or 5 days even if he has had a residual urine of several ounces. This applies particularly to that type of patient who has suffered from repeated attacks of retention but who in the intervals between the attacks is able to empty the bladder quite satisfactorily. I consider about 3 weeks the maximum period that urethral catheter drainage can be continued to

advantage. If by that time the renal function is not sufficiently good to warrant a prostatectomy, a suprapubic cystostomy should be carried out and the prostate removed at a later stage.

#### LIGATURE OF THE VAS

This is a routine procedure done in order to prevent a postoperative epididymitis. If the initial renal functional tests indicate that more than one week of catheter drainage is likely to be necessary, the vas ligation is done as a separate procedure under local anesthesia. If there is to be only a few days of catheter drainage, the ligation is made at the time of the prostatectomy.

The vas is grasped a little below the root of the scrotum and held firmly between the left thumb and index finger. About 20 cubic centimeters of 1 per cent novocain injected subcutaneously and into the cord in an upward direction for about an inch, starting at the level where the vas is held, will usually suffice. Keeping a firm grasp on the vas, a half inch incision is made over the anesthetized area of the cord, the coverings incised, and the vas rolled into the field, where it is grasped with dissecting forceps. It is now separated from the other structures of the cord by blunt dissection and clamped by 2 pressure forceps placed about 1 inch apart. The intervening segment of the vas between the 2 forceps is cut away and a catgut ligature is placed on each end. The skin incision is closed by 2 silkworm sutures. Both sides are dealt with similarly.

#### OPERATIVE TECHNIQUE

Immediately prior to operation and before the patient is brought to the theater, the bladder is washed out with potassium permanganate and emptied. The catheter is removed from urethra and in doing so the urethra is also irrigated with the solution. The penis, scrotum, upper half of thighs, and abdominal wall are surgically prepared.

The operator stands on the left side. The left hand is covered with 2 gloves. The table is tilted into a modified Trendelenburg position, excessive lowering of the head not being considered advisable. The legs are separated to the full width of the table. The towels are arranged so as to facilitate access to the rectum and urethra. Thus the top sheet and side towels should be placed first. A long sheet completely covering the lower limbs and pressed down between the thighs comes next. A split towel through which the penis is drawn is placed over the pubic region and upper thighs. This is covered by a further towel, the upper border of which rests on the symphysis



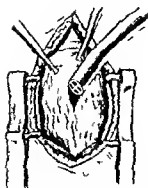


FIG. 1 The extraperitoneal surface of the emptied bladder is pulled upward into the wound by tenaculum forceps and incised. A suction tube is passed down to the retroprostatic area and any residual fluid is evacuated before the incision is extended in the bladder upward.

A median suprapubic incision is made the lower end of which starts 2 finger breadths above the symphysis. A small incision about 2 inches in length is favored but it may be desirable to extend it upward in a patient with a stout pendulous abdominal wall. The skin and subcutaneous fat are incised and the anterior wall of the rectus sheath is exposed and divided in the line of the

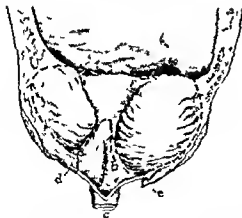


FIG. 3 Copy of illustration in article by the late Harry Hagar (*British Journal of Surgery*, January 1934) showing postmortem specimen of bladder and prostatic urethra opened from the front and indicating the intra-urethral method of enucleation. The broken black line and the arrows thereon indicate the course followed by the finger. a and b are opposite the antero-inferior aspect of each lateral lobe where the enucleation is begun on each side. c and d the cut edges of the muscle of the anterior commissure. e the membranous urethra. f verumontanum.

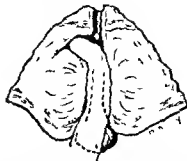


FIG. 2 The right index finger is passed through the internal meatus and prostatic urethra and separation of the prostate is commenced at antero-inferior aspect of left lobe by forcing the finger through the urethra at this point.

incision. The fibers of the rectus muscles are separated in the middle line with blunt pointed scissors. The transversalis fascia is opened and the perivesical fat is brought to view. All bleeding points are now clipped and ligated. The next step is to expose the extraperitoneal surface of the bladder. As the latter is empty and as the abdominal incision and muscle separation do not reach to the symphysis this is somewhat more difficult than when carried out with the bladder distended and a downward extending incision. (In the excessively obese patient it may be preferable to have the bladder distended with about 12 ounces of lotion.) Exposure is facilitated by the use of a small sized, self retaining retractor. The perivesical fat and peritoneum are stroked upward from off the bladder with the aid of a small fold of gauze. The anterior wall of the bladder is usually recognized without difficulty and is grasped by tenaculum forceps. It is pulled upward and backward into the wound. By means of a further pair of tenaculum forceps the position of each is adjusted so that they hold the anterior wall of the bladder on either side of the middle line about one inch apart. While traction on the forceps is maintained a stab incision is made between them. A suction tube is immediately passed into the bladder and any residual fluid is evacuated (Fig. 1). A suture is inserted through each side of the bladder incision and the traction forceps are discarded. The incision in the bladder is sufficiently enlarged in an upward direction to enable the index and middle fingers to be passed through it. If the peritoneum encroaches on the line of incision it is stroked further upward. Any bleeding point on the bladder is ligated and the process of enucleation is carried out.

### ENUCLEATION OF THE PROSTATE

As the abdominal incision and the opening into the bladder are small, the enucleation of the prostate is greatly facilitated by inserting the index and middle fingers of the left hand into the rectum and pushing the gland upward. Before doing this, the left arm is covered down to the wrist with a towel (The left hand is still covered with 2 gloves. The towel and outer glove are discarded as soon as the hand is withdrawn from the rectum). The index and middle fingers of the right hand are inserted into the bladder and the index finger is passed through the internal meatus and prostatic urethra down to the antero-inferior aspect of the left lobe of the gland. The plane of cleavage between it and the prostatic capsule is opened by forcing the finger through the prostatic urethra at this point (Fig 2). The finger is then swept round the lateral surface of the left lobe to the middle line of the posterior aspect of the median lobe. The finger is also made to pass around the inner surface to the middle line of the anterior aspect of the median lobe.

A similar maneuver is carried out on the right lobe (Fig 3). The attachment of the median lobe to the prostatic urethra may be broken with the finger. If this does not readily occur, it should be cut across with scissors. The gland is now delivered backward into the bladder and removed. If it is very large, it may have to be pulled forcibly through the bladder incision with forceps. In the majority of enucleations carried out in this manner, the gland comes away in one whole, consisting of 2 lateral lobes joined together posteriorly by the median lobe and open in front. If no median connecting isthmus is present, each lateral lobe has to be removed separately.

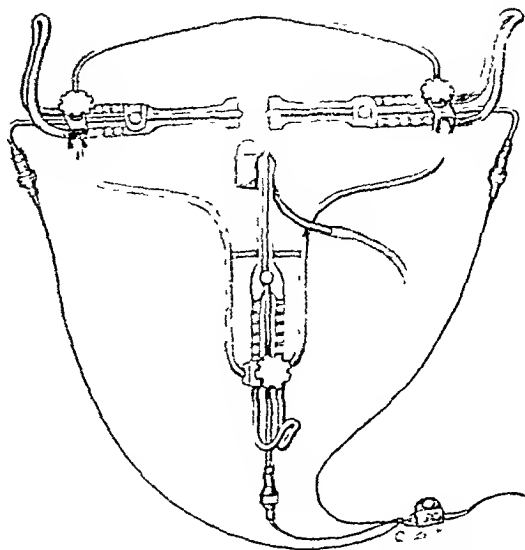


Fig 4 Drawing of Harris's electrically lighted self-retaining bladder retractor with posterior suction blade. The frame rests on the abdominal wall. The narrow blades of the retractor can be inserted into the bladder through a small incision and enable excellent visualization of the prostatic cavity to be obtained. The complete instrument, including lights and cord, is boilable.

### CONTROL OF HEMORRHAGE

A fold of gauze is temporarily packed into the prostatic cavity whilst self-retaining bladder retractors are placed in position. If the bladder exposure has been made through the usual small incision, a Harris retractor (Fig 4) is used. Its narrow blades are easily introduced into the bladder. If a larger incision has been employed, a Morson retractor may be used. Excellent exposure and illumination of the prostatic cavity

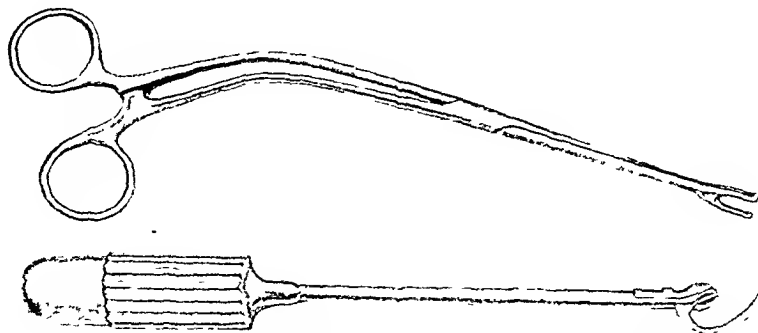


Fig 5 Drawing of Harris's boomcrang needle and ligature carrier.

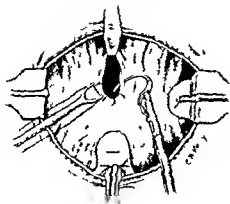


Fig 6 Method for the insertion of the hemostatic sutures along the posterior segment of the rim of the prostate cavity

is obtained with both these retractors, and as the posterior blade of each incorporates a suction aperture, the field is kept free of excessive blood.

A series of catgut sutures (plain catgut No. 2) varying in number from 4 to 7 are inserted through the posterior segment of the rim of the prostatic cavity. Each suture is made to pass through the prostatic capsule in addition to the muscular edge of the rim. The use of the boomerang needle and ligature carrier of Harris (Fig. 5) makes the introduction of these sutures a matter of simplicity. Forward and upward retraction on the anterior margin of the cavity by a long, narrow, bladed retractor facilitates the excursions of the boomerang needle. Before the sutures are inserted any loose tags of mucous membrane or adenomatous tissue are cut away. Bleeding from all spurting vessels should be controlled after these sutures have been placed (Fig. 6). If any considerable ooze still occurs from the raw surface of the anterior portion of the prostatic bed a transverse suture is passed by means of a larger sized boomerang needle through the side walls of the urethra. It is inserted just proximal to the anterior margin of the cavity and tangent to it. When tied it causes an inversion of the rim of the cavity and thus further controls the bleeding (Fig. 7).

A two-eyed catheter, No. 22 F mounted on a stillette is then passed along the urethra into the bladder. Its tip is cut off transversely just beyond the distal eye. A long silkworm gut suture is introduced through the end of the catheter and the position of the latter is adjusted so that only the eyes project just within the bladder. The

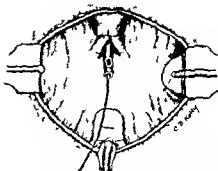


Fig 7 An anterior transverse suture has been passed through side walls of urethra and tied. The catheter with tip cut off is in position and transfixed by the suture.

maintenance of this position until the catheter suture has been hitched to the abdominal wall is ensured by grasping the catheter with a light clamp just beyond the point of the penis. The retractors are removed and a Freyer's tube size 18-20 millimeters, with a glass bend to which is connected a 16 inch length of rubber tubing, is inserted into the bladder. Along with the catheter thread the tube is delivered through the upper extremity of the bladder incision. The latter is closed by 3 or 4 interrupted chromic catgut sutures No. 2. The ends of the catheter suture are threaded on needles and passed through the skin on one side about half an inch lateral to the edge and about half an inch apart. They are tied over a piece of rubber. While making the knot, the catheter is pulled to the full extent that the forceps, which have been placed or it will allow. The tube is made to traverse the lower end of the abdominal incision which is closed above it by a continuous suture of No. 3 chromic catgut through the rectus sheath and interrupted sutures of silkworm gut through the skin.

Before the dressing is applied the bladder is irrigated through the urethral catheter and supra-pubic tube with hot saline. The dressing is fixed to the abdominal wall by adhesive trapping with the glass bend left visible for inspection.

#### POSTOPERATIVE CARE

When the patient is returned to bed the catheter is connected by a wide glass connection to a length of rubber tubing which drains into a bottle containing anti-epic at the side of the bed. The rubber tubing connected to the glass bend of the supra-pubic tube is drained into a separate receptacle (Fig. 8). One saline injection only is

given after operation, 10 ounces being allowed to run slowly into the rectum. At the first sign of restlessness on the part of the patient when coming out of the anesthetic, one third grain of omnopon with one hundredth grain of atropine is given. This may be repeated on 1, 2, or 3 occasions during the first 24 hours, after which it will probably not be required. Should any clotting take place, this will be apparent at once in the glass-bend and immediate irrigation with warm silver nitrate (1 to 10,000) is carried out. If this occurs at all, it rarely does so after the first 12 hours. A bladder wash-out, however, is given on the first and second days. On the second day the suprapubic tube is removed and a dressing is applied over the wound. If after a few hours any considerable suprapubic urinary soakage occurs, a suprapubic box is applied in lieu of the dressing. Otherwise changing the dressing twice a day will suffice. On the morning of the third day a ½ ounce of castor oil is given and 1 hour later 6 ounces of olive oil are gently run into the rectum.

The urethral catheter is removed on the sixth day by cutting across both ends of the suture which retains it, below the knot. On withdrawal of the catheter the suture comes away with it. During the period that the catheter has been in the urethra, the bladder is irrigated once daily with 2 pints of weak silver nitrate solution (1 to 10,000). It is convenient to have a suprapubic box placed over the wound during the wash-out if one has not been required for routine purposes. The patient is usually allowed up on or about the twelfth day when he is generally voiding urine. The majority are completely dry within 3 weeks.

Throughout the period of convalescence, diuresis is kept up to a maximum degree compatible with the patient's comfort. He is encouraged and, if necessary, cajoled to drink at least 5 pints of fluids daily. Starting with water, cold or warm, the fluids are varied after the first 2 days. Lemon water, lemon and barley, orange water, weak lemonade, and buttermilk are alternatives with which the patient is tempted to maintain his fluid intake. I have no hesitation in allowing 1 to 2 pints of weak lager beer daily. It is an excellent diuretic and to some is a welcome change from the above mentioned blander types of fluids. If for any reason, the fluid intake is not satisfactory and the urinary output is at a dangerously low level, intravenous infusion of normal saline or dextrose (5 per cent) in normal saline must be instituted. If this must be maintained, it is given by the "drip" method.

Satisfactory urinary antiseptic treatment in the early stages after operation is difficult, as the

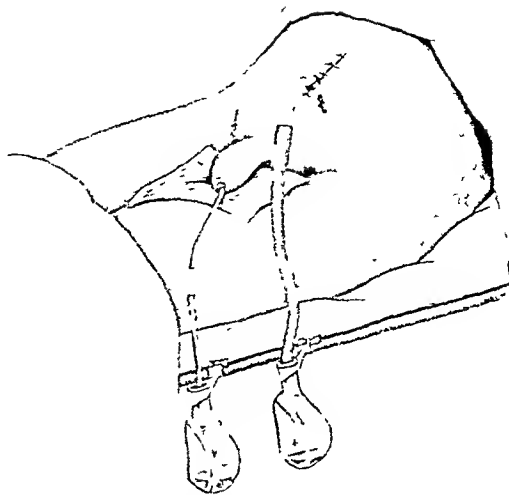


Fig 8 Method of draining the bladder immediately after operation. The catheter suture is seen on the left side of the wound tied over a piece of rubber.

urine tends to remain persistently alkaline as long as a suprapubic fistula is present. The flushing effect of the diuresis and the bladder lavage are probably the best forms of antisepsis but the urine should be rendered acid as soon as possible with acid sodium phosphate or ammonium chloride. Hexamine is then also given.

#### TWO STAGE PROSTATECTOMY

If because of impaired renal function or other reason, a preliminary suprapubic cystostomy has been carried out, removal of the prostate should not be performed until the elapse of at least 4 weeks. By this time healing in the deeper layers of the suprapubic wound will have taken place and postoperative reaction subsided. In cases of marked renal impairment it may be necessary to wait several months until the maximum recovery of the kidneys has taken place. There are certain patients with permanent renal insufficiency indicated by repeatedly poor renal functional tests who, nevertheless, can be safely brought through a two stage prostatectomy. If diuresis can be forced up to about 100 ounces per day and stabilized, and if the clinical condition of the patient is otherwise satisfactory, I believe that the operation can be performed without undue increase of risk. A recent case of this type was submitted to a successful prostatectomy 10 weeks after a cystostomy with a blood urea which remained persistently around 65 milligrams per cent.

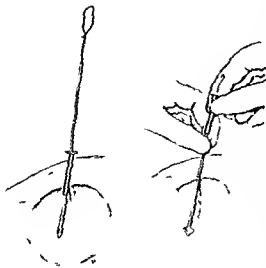


Fig. 9. left. The distended bladder has been punctured with a trocar and cannula. The trocar has been withdrawn and a Malecot tube stretched on an introducer has been passed through the cannula.

Fig. 10. With the tube still stretched on the introducer the cannula is withdrawn from the wound. The introducer is removed, thus allowing the tube to expand and the end to open out. The tube below cannula is steadied and later withdrawn. A water tight suprapubic drainage results.

The preliminary cystostomy opening should always be made as high as possible above the level of the symphysis. A distance of 2 inches should be aimed at. This facilitates the second stage and in addition will be advantageous to the patient in the event of either permanent or prolonged temporary drainage proving necessary, as it ensures the easier fitting of a suprapubic apparatus. My preference is to puncture the distended bladder with a trocar and cannula and to insert a Malecot tube size 28 Charniere through the cannula. This can be done through an incision 1 inch in length. The rectus sheath is incised and the fibers of the rectus muscles separated. The left index finger is passed down to the bladder and with it the peritoneal fat and peritoneum are stroked upward. The trocar with cannula is sharply thrust into the bladder in front of the finger. The trocar is withdrawn and the Malecot tube stretched on an introducer is passed through the cannula. The tube is kept stretched and fixed in position while the cannula is withdrawn outside the incision. The hold on the tube is now relaxed the introducer is removed and grasping

the tube just outside the abdominal wall and steadying it the operator withdraws the cannula completely (Figs 9 and 10). One catgut suture (or none) through the rectus sheath and 1 or 2 stitches through the skin completes the operation which can be done under local anesthesia. It is permissible to use this method through a small incision, only when the bladder can be satisfactorily distended and is palpable through the abdominal wall. When calculi have to be removed or when the bladder cannot be adequately distended, as is sometimes the case after it has been subjected to continuous urethral catheter drainage exposure through a larger incision will be necessary.

The incision for prostatectomy, when a cystostomy opening is present, passes for about 1 inch above and below the fistula which is encircled and excised. The bladder is separated by sharp dissection from off the under surface of the rectus muscle and is incised downward from the opening. The operation is then proceeded with after the manner described for the one stage operation. It may be found however that the abdominal wall is less pliable and that the bladder wall does not separate off easily. In these circumstances adequate retraction and good exposure of the prostatic cavity may be difficult. In the majority of two stage prostatectomies however there is less tendency to profuse bleeding after the enucleation of the gland and thus if visualization of the cavity is difficult insertion of the hemostatic sutures can be dispensed with. A larger tube size 22/24 millimeter, should be used however, to drain the bladder. If any anxiety is felt as to bleeding the prostatic cavity should be packed with gauze which is delivered through the wound alongside the tube.

The postoperative care is similar to that described for the one stage operation. If packing has been inserted the bladder is not irrigated until the second day when the packing and suprapubic tube are removed. Washing the bladder through the urethral catheter will soften the gauze and facilitate its removal.

LONGLESTON

The technique described is, I consider the safest method of performing suprapubic prostatectomy. It reduces to a minimum the risks of hemorrhage and infection and is least likely to be followed by any postoperative morbidity such as vesical neck contracture or secondary calculus formations.

# IMMEDIATE FULL THICKNESS GRAFTS TO FINGER TIPS

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A WORKINGMAN'S hands are one of his most valuable assets. Loss of any part or function of the hand reduces his potential earning power. Amputated fingers or painful finger-end scars manifest themselves in the pay envelope. Therefore, any step to improve results after injury of finger ends will be received gratefully by the workingman.

I wish to describe a minor operation to be used in certain types of injury to the finger end which averts necessity for amputation or its alternative, thin-skinned, painful scar. The type of injury for which this operation is applicable consists in loss of soft tissues of the finger end, usually without loss of bone, such injuries as are sustained in slicing machines, with saws, in punch presses, or by pinching. The tissue loss may involve only the distal tip, skin, and soft tissues, sometimes exposing the bone. It may include one side of the whole distal phalanx sometimes involving the nail. It may remove the whole palmar pad (Fig 1).

In each of these situations, bone shortening must be performed if the flaps are to be brought together over the bone. And if such lesions are permitted to granulate and heal in, the thick, dense, fibrous scar, covered by thin cicatricial skin, results in a permanently painful scar which, on a finger end, seriously impairs the function of the hand.

Such lesions can well be closed, I have found, with an immediate full thickness graft applied to the area of soft tissue loss. Full thickness grafts have been used with increasing frequency in recent years. Bunnell, Koch (5, 6), McWilliams, Padgett, and Updegraff, among many others, have cited their applicability in covering soft tissue defects. J S Davis, in 1926, did particularly interesting experimental work on the nutrition of transplanted skin tissue, concluding that in the first 24 hours a graft gets its nourishment from lymph flow from the bed, in the next few days by invasion of blood from the periphery, and that the graft does not develop adequate blood supply until 8 to 10 days. Blair emphasized the desirability of full-thickness grafts to avoid contracture. Koch (6), in 1931, and T S O'Malley, in 1934, described the use of grafts for amputated finger ends. They both, however, ap-

plied the grafts to already amputated fingers to prevent further shortening of bone. O'Malley in his paper gave interesting statistics from the Wisconsin Industrial Board on the economic loss due to amputations of fingers.

Immediate full thickness grafts to injured finger tips can be done in the office or in the home. The technique is simple. The results in our experience have been quite satisfactory (Figs 2, 3, 4, 5, and 7).

The whole hand is very thoroughly scrubbed including the base of the injured finger. A local anesthetic of 2 per cent novocain with adrenalin is injected on each side in the proximal segment of the finger. Then the donor site is selected. Usually this is the volar aspect of the proximal fourth of the same forearm. In females, the lateral aspect of the thigh near the ilium is chosen in an effort to place the scar where it will be at all times covered. In one man this site was selected because other desirable sites were covered with lesions of psoriasis. The donor site is shaved and scrubbed thoroughly clean. No antiseptic dyes are used because of the possibility that they might cause injury to the graft.

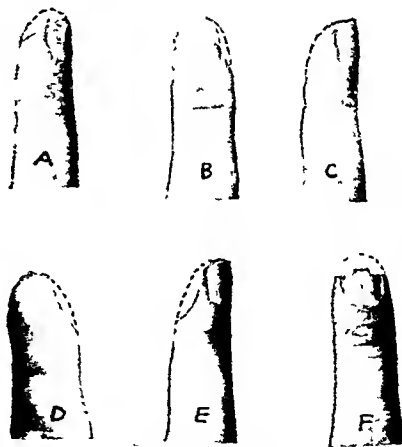


Fig 1 Types of injury requiring graft. A, Slice wound tip, not exposing bone. B, Loss of one side of distal segment and nail. C, Slice wound of pad without exposing bone. D, Loss of soft tissues side of digit without injuring nail. E, Avulsion of pad of finger exposing palmar aspect of distal phalanx. F, Loss of soft tissue exposing tip of phalanx.

## ANALYSIS OF RESULTS IN 53 CASES

Case	Age	Date of injury	Date of admission to work	Date of discharge	Diagnosis	Mechanism of injury	Result
1	45	9-18-34	10-22-34	10-30-34	L.T.	Machine in feet rollers	No permanent impairment
2	54	2-3-35	2-31-35	1-3-35	R.M.	Machine between wrench and nut	No permanent impairment
3	45	2-2-34	1-1-35	2-12-35	L.M.	Caught in a screw machine	No permanent impairment
4	21	1-11-35	2-25-35	2-5-35	R.R.	Caught in a gear teeth	Impairment amounted to 25 per cent
5	51	10-3-35	1-2-35	2-3-35	L.M.	Caught in punch press	No permanent impairment
6	5	11-3-35	3-25-35	4-6-35	R.I.	Bit of a tray fed through skin pieces	Impairment amounted to 30 per cent
7	47	4-3-35	4-2-35	3-8-35	L.L.	Cut with steel chip—pad amputated	No permanent impairment
8	41	3-19-35	—	—	R.R.	Cut in glass—middle finger missing	Amputation of middle finger at distal phalanx
9	47	6-16-35	7-6-35	7-10-35	R.I.	Cut with power saw	No permanent impairment
10	25	7-3-35	8-22-35	8-20-35	R.R.	Caught between table and shale	Impairment amounted to 15 per cent
11	35	7-3-35	8-5-35	8-6-35	R.I.	Cut in punch press	No permanent impairment
12	64	7-8-35	9-3-35	11-1-35	R.I.	Caught in machine	Compound fracture with 30 per cent atrophy of hand
13	51	8-9-35	9-13-35	2-10-35	R.M.	Fingered off by steel die	No permanent impairment in distal phalanx
14	41	8-14-35	8-30-35	10-12-35	R.M.	Cut with power saw	No permanent impairment
15	36	9-5-35	9-6-35	10-19-35	L.I.	Cut in kick press	Impairment amounted to 1 per cent
16	44	9-18-35	1-3-35	1-16-35	R.I.	Cut with power saw	Impairment amounted to 30 per cent if graft excised but bone occurred
17*	25	9-14-35	10-5-35	12-13-35	L.L.	Cut with a chipper	No permanent impairment in distal phalanx
18	22	9-18-35	9-29-35	11-3-35	R.M.	Plane amputated tip	No permanent impairment
19	10	9-11-35	—	—	L.M.	Cut on roll—steel	No permanent impairment
20	27	10-1-35	1-4-35	3-12-35	R.I. & M.	Caught in a barrel—avulsion of pad	No permanent impairment
21	21	1-5-35	1-7-35	2-9-35	L.I.	Cut in machine	No permanent impairment
22	28	12-9-35	10-35	24-35	L.M.	Caught in machine	No permanent impairment
23	51	2-5-36	3-16	3-27-36	R.M.	Fingered off in car door	No permanent impairment
24	16	6-18-36	7-10-36	4-2-36	L.T.	Cut with power saw	No permanent impairment
25†	19	2-7-36	4-10-36	5-9-36	R.I. & R.R.	Cut in punch press	Impairment amounted to 20 per cent if each finger
26	55	4-12-36	4-4-36	3-30	L.M.	Fingered off by a dropping	No permanent impairment
27	15	4-14-36	6-9-36	6-24-36	R.I. & R.R.	Caught in machine	No permanent impairment
28	50	5-14-36	7-3-36	7-1-36	R.I.	Cut in a screw face	No permanent impairment in fingers
29	9	5-27-36	7-1-36	7-5-36	L.I.	Torn off by a peeler	Cut a good bit—amputated
30	19	6-18-36	7-10	8-6-36	L.M. & R.R.	Cut in punch press	No permanent impairment in fingers if fingers were not slipped
31	23	6-5-36	8-7-36	8-24-36	L.T.	Cut in gears	No permanent impairment in fingers
32	3	5-30-36	6-8-36	8-21-36	R.I.	Fingered off by a peeler	No permanent impairment
33	48	8-2-36	8-4-36	9-19-36	L.R.	Caught in punch press	No permanent impairment in fingers
34	19	8-1-36	9-30	9-30-36	L.R.	Cut in gears	No permanent impairment
35	8	8-7-36	8-9-36	10-1-36	R.R.	Caught in a screw face	No permanent impairment
36	49	9-3-36	10-3-36	10-25-36	R.M.	Slid on a sharp tool	No permanent impairment
37	50	9-3-36	9-30	1-5-37	R.I.	Machine in machine	Impairment in fingers to 25 per cent if fingers
38	1	9-1-36	9-25-36	7-36	R.I. & R.R.	Cut in punch press	Cut in fingers in fingers to 50 per cent if fingers

All patients were white with  
 14 patients were male in this  
 except 1

## ANALYSIS OF RESULTS IN 53 CASES—Continued

Case	Age	Date of injury	Date of return to work	Date of discharge	Digit involved	Manner of injury	End-results
39	21	10-28-36	12- 2-36	12-18-36	L I	Caught in kick press	Impairment to 25 per cent due to scar
40	38	11-23-36	1- 4-37	1- 4-37	R I	Caught in drum of machine	No permanent impairment
41	19	1- 4-37	2- 3-37	5-17-37	R R	Cutter sliced off finger	450 per cent bone loss and nail dystrophy, a prolonged case
42*	31	1-29-37	3-22-37	4-27-37	R R	Caught in cogs	Impairment of 10 per cent, a large graft required because of an exceptionally bad phalanx exposed on palmar aspect and tip
43	19	2- 5-37	3- 1-37	4-24-37	L M	Caught in punch press	A bony loss of 50 per cent, patient was a piano player
44	52	3-12-37	3-15-37	4-17-37	L I	Caught in air press	No permanent impairment
45	25	6-23-37	7-19-37	8- 2-37	R M	Casting mashed finger	Impairment amounted to 10 per cent, tenderness
46	31	6-26-37	7-24-37	7-31-37	L I	Caught in bottle crowner	No permanent impairment
47	28	7-28-37	8-16-37	9- 1-37	L M	Pinched between rack and door	Impairment of 50 per cent due to bone loss
48	25	8-20-37	9-20-37	10- 2-37	R I	Caught in punch press	No permanent impairment to finger grafted, 2 other fingers amputated at same time
49	48	10- 6-37	10-26-37	12-18-37	L L	Pinched between cable and drum	No permanent impairment
50	18	11- 3-37	12-15-37	1-13-38	L M	Caught in food grinder	Impairment amounted to 50 per cent, graft sloughed, bone loss and painful scar
51	42	12- 4-37	1- 5-38	1-11-38	R T	Cut with power saw	No permanent impairment
52	60	12-21-37	1-24-38	2-10-38	L I	Pinched in machine	Graft good but a 50 per cent bone loss
53†	26	12-26-37	2- 3-38	2-16-38	R I	Pinched in roller	Impairment amounted to 30 per cent, a finger nail deformity

\*All patients were white with 2 exceptions

†All patients were male with 2 exceptions

A horse shoe shaped line (open distally) is then injected with local anesthetic leaving within its perimeter an area of skin amply sized for the graft. By this time the injured finger end is numb. Loose tags of skin are trimmed and the finger very thoroughly scrubbed. No hemostasis is applied except pressure. The terminal arteries in the finger rarely require ligature. The knotted ligature beneath a graft is undesirable. The blood supply should not be impaired unnecessarily.

After the lesion is thoroughly cleansed, a pattern is made of the skin defect. This may be made by outlining the defect on sterile gold foil, mesh, or crinolin. A much simpler method may be used. A smooth gauze pad of about 2 or 3 thicknesses is pressed firmly on the lesion and immediately pressed on the donor site. The transfer of moisture and blood stain so accomplished outlines the size and shape of the graft very well.

The pattern is outlined with a sharp scalpel. Near the margin of the graft care must be taken to separate the skin from subcutaneous tissue accurately. This is not so important toward the center of the graft. In fact when the bone in the finger end is projecting or when the pad of the finger has been avulsed, it is desirable to include some subcutaneous fat attached to the center of the graft. The removal of the graft should be

done as rapidly as consistent with good surgery and handled as little as possible to preserve the vascular channels within the graft. Immediate full thickness grafts get their blood supply from the margins of their new site *only*, in the first 24 hours.

The graft is immediately transferred to the injured finger and sutured into place by means of very small cutting edge needles and "A" silk. The sutures should be interrupted, continuous sutures choke off blood supply. If the pattern has been made accurately, the graft will be under slight tension when the suturing is complete. The suture ends should be carefully directed away from the graft so that none of them adhere to it or press down in it. A dry gauze square is then placed over the graft and held in place with a moderately tight bandage. The donor site is closed in a straight line, either transverse or sagittal, by undermining the margins.

The patient is advised to keep the hand dependent a part of the time. The dressings are not changed for 5 days. The sutures are not removed from the perimeter of the graft for 2 weeks. Usually at the end of 5 days the graft is pink and dry. Dressings can usually be left off after about 4 weeks. On removal of the dressings, the graft appears similar to the surrounding skin except

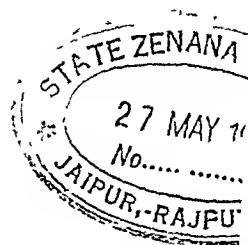


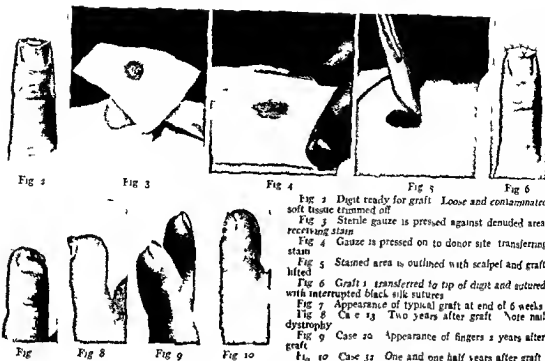


The technique is simple. The end-results are satisfactory to the individual, to the surgeon, and to the person, or to the company liable for the injury

# REFERENCES

- 1 BLAIR, V P The full-thickness skin graft Ann Surg, 1924, 80 298
- 2 BUNNELL, S Reconstructive surgery of the hand Surg, Gynec & Obst, 1924, 39 259
- 3 DAVIS, J S, and TRAUT, H F Origin and development of blood supply of whole-thickness skin grafts, an experimental study Ann Surg, 1925, 82 871
- 4 KOCH, S L The covering of raw surfaces with particular reference to the hand Surg, Gynec & Obst, 1926 43, 677
- 5 Idem The immediate treatment of injuries of the hand Surg, Gynec & Obst, 1931, 52 594
- 6 McWILLIAMS, C A Free full-thickness skin grafts Ann Surg, 1926, 84 237
- 7 O'MALLEY, T S Full-thickness grafts in finger amputations Wisconsin M J, 1934, 33 337
- 8 PADGETT, E C Full-thickness grafts in correction of soft tissue deformities J Am M. Ass, 1932, 98 18
- 9 UPDEGRAFF, H L Changing of fingerprints Am J Surg, 1934, 26 533





that fine hairs transferred in the graft may be seen (Figs 7, 8, 9 and 10).

In the practice of the Indianapolis Industrial Clinic this operation was performed 57 times between September 1934 and January 1, 1938 on 53 patients. In each instance, further amputation would have been necessary to avoid painful scar. Thirty three of these fingers healed without any permanent impairment. Of the 24 remaining 9 were adjudged permanently impaired because of material bony shortening occurring with the injury. In these instances the graft was performed to prevent further shortening. One was a pianist another played a stringed instrument.

In the 15 remaining, were complete failures of the graft. In 1 of these 3 another finger of the same hand required constant hot fomentations and the grafted finger was soaked with it. The graft sloughed completely and subsequent amputation was necessary. In the 2 others the graft sloughed because of lack of nutrition. The resulting scar was somewhat better than could have been anticipated without graft. The 12 others were considered 10 to 35 per cent impaired due to dystrophy of the nail or deformity of the finger end without shortening.

An interesting analysis of these 57 digits from an economic viewpoint is given in the accompanying

Fig. 1 Digit ready for graft. Loose and contaminated soft tissue trimmed off.

Fig. 3 Sterile gauze is pressed against denuded area receiving stain.

Fig. 4 Gauze is pressed on to donor site transferring stain.

Fig. 5 Stained area is outlined with scalpel and graft lifted.

Fig. 6 Graft is transferred to tip of digit and sutured with interrupted black silk sutures.

Fig. 7 Appearance of typical graft at end of 6 weeks.

Fig. 8 Case 13. Two years after graft. Note nail dystrophy.

Fig. 9 Case 20. Appearance of fingers 2 years after graft.

Fig. 10 Case 31. One and one half years after graft.

ing table. Under the Indiana Compensation Law specific permanent impairment allowances are made for the loss of each digit: 80 weeks compensation for the thumb, 40 weeks for the index finger, 35 weeks for the middle finger, 30 weeks for the ring finger and 20 weeks for the little finger. Bone shortening distal to the proximal interphalangeal articulation calls for one half of the respective amount. The law specifies that a material bone loss from the distal end of the bone constitutes bone shortening.

In each of these cases then if not grafted there would have been bone shortening with a loss to the insurance company of one half the digit. The total loss so incurred would have amounted to 104 1/2 weeks of compensation. The actual period of disabilities of these cases totaled 191 weeks. Additional compensation payments for permanent impairments in the whole series totaled 184 weeks. 375 weeks of compensation were paid. This operation then can be credited with saving 670 weeks of compensation besides the conservation of tissues and improvement of function for the patient.

#### CONCLUSIONS

An immediate full thickness graft applied to a finger end suffering soft tissue loss conserves length and averts painful scar.

Figure 1a is an enlarged view of the field of operation, it shows the marked normal shrinkage of the dermigrraft when the dermis is cut completely through to the fat, and also the retraction of the skin edges. Note that sutures have been placed at cardinal points through the dermigrraft, these sutures may be used instead of a hook for lifting the graft when dissecting it free from the underlying fat. They also may be rethreaded and used subsequently to suture the graft into its new bed.

Figure 2 shows the defect in the donor site recovered with its own skin, the reflected strips of epidermis having been returned to their original positions. If the grafts are large, V-shaped incisions are made in them here and there in order to allow the immediate escape of air bubbles and the subsequent discharge of serum. This is essential, as absolute contact of the graft to its bed is necessary for success.

When a subepidermal graft is prepared in the manner described—care having been taken to make the epidermal reflections as thin as possible—only a small amount of punctate bleeding will follow from the cut tips of the dermal papillæ, between these papillæ in the depths of the corium islands of the basal cell layer (rete pegs) are left behind, and it is from the remains of these rete pegs that the skin in the transplanted dermigrraft is regenerated, just as is the case in any sta-

tionary site from which Thiersch grafts are removed.

Following my experiments with this method, first upon the human cadaver, and later upon rabbits, Dr V H Kazanjian of Boston utilized it clinically. His patient was a man of 40 who required an extensive plastic operation on the side of his face. In one of the stages of operative reconstruction, an area on the side of his neck, measuring  $\frac{1}{2}$  inch by  $1\frac{1}{2}$  inches in diameter, was covered with a dermigrraft. The survival of the graft and the re-epithelialization of the donor area on the thigh were regarded as an experimental success, although the defect in this case was too small to prove the practical value of the method.

Details of the operative technique, dressings, etc., have been omitted from this preliminary discussion, since they may be subject to such wide variation in different hands. The main principles, however, are similar to those which have been laid down for the transplantation of skin in general. Although the method as described is, as yet, little more than a suggestion, it is hoped that it may prove to be an interesting addition to the armamentarium of the plastic surgeon.

Dr E B Potter, department of surgery, University of Michigan Medical School, rendered valuable assistance with the operative technique in the animal experiments.

# THE DERMIGRAFT

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**T**HE method of skin grafting that I am about to describe was developed experimentally for the purpose of correcting certain disadvantages inherent in the Wolfe Krause whole thickness graft. A thick graft is generally superior to a thin graft of the Ollier Thiersch type for the following reasons. It contains all the dermal elements and remains soft and natural in texture, it has a higher resistance to infection, a "take" is fairly certain with proper technique and a clean field, it gives better protection to weight bearing surfaces. A large surface may be covered with minimal contracture, a successful "take" will, in most cases closely simulate the natural cutaneous surface and, in a previously depressed area, some months later a thin layer of fatty tissue is deposited almost always beneath the graft so that it rises to the level of the surrounding skin. Thick skin grafts may be used in almost any situation but are especially useful for covering joints and other parts of extremities where there is constant exposure to trauma for example defects in the popliteal space, the elbow, the forearm, the leg

and both aspects of the hand. They are also useful in re-epithelializing raw surfaces after deforming scar contracture in the palms of the hands back of the neck, and on the face, after excision of nevus and for old chronic ulcers.

A serious disadvantage, however, lies in the fact that a Wolfe graft, if large leaves a fresh defect at the donor site which in turn may require further grafting. The dual rôle of the dermigraft is designed to overcome this shortcoming. On the one hand it provides a means of removing large thick skin grafts from a given area on the other, it enables one to re-epithelialize the resulting defect in this area with its own skin, and in one operation.

In Figure 1, strips of epidermis have been cut and reflected back upon a piece of gutta percha like Thiersch grafts, the bases of the strips however, remaining attached in order to retain the blood supply intact. In the rectangular, sub-epidermal area which has thus been exposed a graft is measured to fit the recipient defect. This graft is outlined with a scalpel, the incision going through the remainder of the corium.

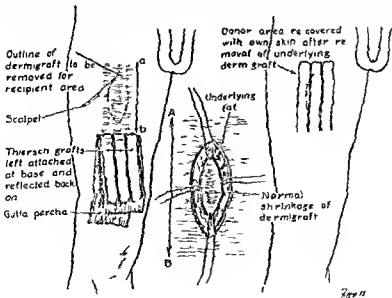


Fig. 1

Fig. 2a

Fig. 2

# CASE REPORT

B U I 25,174, T E H, aged 51 years, was seen October 6, 1936. He complained of recurrent colic-like attacks of pain in the right flank for 20 months. The pain was incapacitating and accompanied by frequency and urgency of urination and pyuria. A leg and the 5 lower ribs on the right side had been fractured in an automobile accident in 1924.

The abdomen was thin and relaxed and there was tenderness in the right flank and costovertebral angle. The genitalia were normal. The prostate was slightly enlarged. The hemoglobin was 95 per cent, white blood cells 10,200, blood pressure 108/70, and blood urea 40.

Cystoscopy showed a normal bladder and vesical orifice. From the right ureteral orifice exuded a thick, viscid, mucopurulent stream, the left ureteral orifice was normal and emitted clear urine. Catheterized specimens from both ureters were sterile on culture. The results of the phthalein test were as follows: right ureter, only a trace of phthalein, left side, appearance time 4 minutes, 25 per cent output in 15 minutes.

A plain urogram (Fig 2) showed what was thought to be a calcified hematoma inside the right kidney, which was practically functionless as a result of traumatic rupture.

Operation, October 12, 1936, was begun with the patient under spinal anesthesia, but nitrous-oxid, oxygen and ether were later necessary on account of pain. An incision to expose the kidney was made from just beneath the middle of the twelfth rib down to well below the tip toward the umbilicus. The external and internal oblique muscles were divided, thus exposing the lumbodorsal fascia, which was then opened, with retraction and preservation of the iliohypogastric nerve. Gerota's fascia did not have the normal appearance, but was replaced by a thick, fibrous scar, firmly adherent to the ribs and diaphragm (Fig 1). It was apparent that the kidney

had been previously ruptured, and the true capsule together with Gerota's fascia, perirenal fat, and peritoneum had been converted into a thick, dense, fibrous tissue. Approximately an hour was spent in attempting to find a plane of cleavage so as to identify the surface of the kidney. The ideal procedure would have been an intracapsular nephrectomy, but the renal fossa was so filled by cicatrix that the surface of the kidney could not be identified.

As nephrectomy was imperative, we then attempted to remove the fibrous mass in which the right kidney was situated. It was necessary to cut the scar away from the inner surface of the previously fractured lower ribs and the diaphragm, in so doing an opening into the diaphragm of about 3 finger-breadths was made (Fig 1). The usual sucking noise was heard. This opening was tightly packed with gauze because it was not feasible to attempt suture until the kidney was removed. The fibrotic kidney was finally located and the pedicle sufficiently isolated so that clamps could be placed. After the kidney was removed the stump of the pedicle was ligated with two No. 3 chromic catgut sutures.

As there were cavities containing purulent material surrounding the kidney, every effort was made to close the opening in the diaphragm. Eight sutures were placed through either side to bring the torn margins together, but without success. While this was being attempted, positive pressure was alternately carried out by the anesthetist with the inhalation machine so as to reduce the pneumothorax to a minimum and also to push the edges of the diaphragm down so they could be caught with the needle.



Fig 2 Roentgenogram showing large, irregular shadow in region of right kidney (B U I 25174)

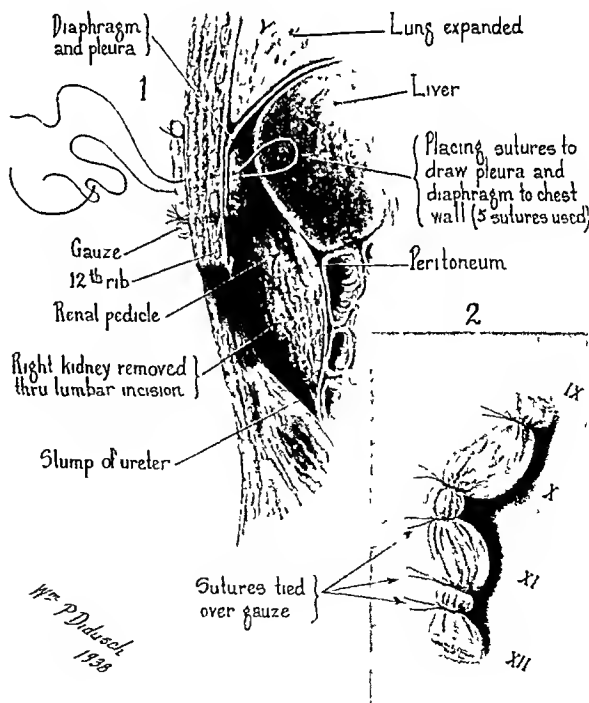


Fig 3 Showing manner in which mattress sutures were placed to close large opening through diaphragm (B U I 25174)

# DIAPHRAGMATIC INJURY COMPLICATING NEPHRECTOMY

## A Method of Closure

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**I**NJURY of the pleura during renal operations is not uncommon and traumatism to the diaphragm is not rare. Mayo reported that the pleural cavity was opened 13 times in 203 renal operations. Frequently insuperable obstacles to satisfactory closure have been reported by various operators. As a result gauze packing placed in the pleural and diaphragmatic tears has been used frequently.

We have recently had a case in which a previously ruptured kidney was surrounded by such dense adhesions that, while carrying out nephrectomy, an extensive tear was made through the diaphragm into the pleural cavity. Approximation of the torn edges was impossible. With full knowledge of the poor results that often followed the use of a gauze pack in such cases, we determined to make every effort to close the defect.

From the James Buchanan Brady Urological Institute, Johns Hopkins Hospital.

Being unable to approximate the edges, we finally discovered that by placing mattress sutures between the ribs and out through the skin so as to draw the inner edge of the ruptured diaphragm snugly against the chest wall, effective closure of the large diaphragmatic opening could be obtained without difficulty. The condition present (which will be described in the case report) is shown graphically in Figure 1. The large tear in the diaphragm is shown in Figure 2. The technique which effected complete closure and obliteration of the space in a simple way, is shown in Figure 3. The diaphragm was drawn by mattress sutures which emerged from the skin and held the diaphragm snugly against the chest wall. After a careful survey of the literature, it seems that this technique has not been employed previously. It has proved so satisfactory in handling an extensive diaphragmatic injury that a detailed report of the operation seems warranted.

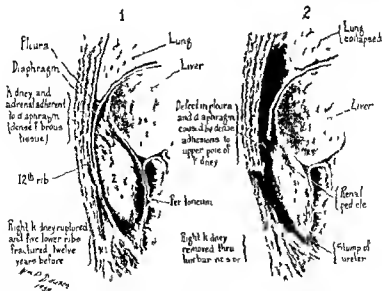


Fig. 1. Schematic drawing showing small sclerotic kidney very adherent to diaphragm. 2. Showing condition after removal of kidney and ligament pedicle. A large tear through diaphragm into pleural cavity (B. L. I. 25174).

phragm was caught by sutures and tied outside. The patient died immediately after operation. No case similar to ours has been found in the literature

# CONCLUSIONS

Accidental injuries to the diaphragm and pleura are not infrequent occurrences during exposure of the kidney. Most of these are readily sutured and rarely cause serious complication, although reports of mortality from this simple accident have been made by Fronstein and others. More extensive injuries to the diaphragm incident to delivering the upper pole of the kidney in cases with marked perinephric adhesions and scar formation are rarely encountered, but when they do occur, the closure may present a difficult surgical problem. They have usually been packed with gauze, but such treatment is often followed by serious complications and should be avoided.

A case is herewith reported of extensive injury to the diaphragm during nephrectomy resulting from dense perinephric adhesions and scar. A technique is reported for the use of traction sutures

introduced transpleurally through the skin to draw the diaphragm against the chest wall and close the rent in the pleura. The operation is so simple that its value is emphasized in the operative handling of these diaphragmatic injuries.

# BIBLIOGRAPHY

- 1 BETTMAN *Am J Surg*, 1929, 6 449
- 2 BRYAN *Surg, Gynec & Obst*, 1927, 45 688
- 3 FOLEY *Arch Surg*, 1929, 18 1413
- 4 FRONSTEIN Quoted by Peirson and Staples, loc cit
- 5 GAZA *Zentralbl f Chir*, 1926, 53 886
- 6 GOLDSTEIN *Surg, Gynec & Obst*, 1937, 65 512
- 7 HRSSE *Beitr z klin Chir*, 1924, 132 215
- 8 HEUER, ANDRUS, and BELL *Ann Surg*, 1925, 81 273
- 9 MATHÉ *Calif & West Med*, 1928, 28 57
- 10 MAYLARD Quoted by Moore, loc cit
- 11 MAYO *Ann Surg*, 1912, 55 63
- 12 MOORE *Surg, Gynec & Obst*, 1935, 61 58
- 13 PEIRSON and STAPLES *Urol & Cut Rev*, 1935, 39 843
- 14 QUINBY *J Am M Ass*, 1926, 86 1189
- 15 RATHBUN *J Urol*, 1928, 20 427
- 16 SCHOLL *Cabot's Modern Urology* 3d ed Philadelphia Lea & Febiger, 1936
- 17 TILTON and SCHROEDER *Med J & Rec*, 1929, 129 444



It then occurred to us that the large tear could be obliterated by drawing the diaphragm against the chest wall. The technique employed was as follows: Five mattress sutures of heavy chromic catgut were placed in the medial margin of the diaphragmatic opening. With a large curved cutting needle these sutures were carried across the diaphragmatic defect transversely and through the intercostal muscles of the tenth and eleventh rib (Fig. 3) and brought out through the skin. When they were pulled taut we could feel the medial margin of the diaphragmatic defect shift laterally until it was brought tightly against the chest wall; no further sucking noise was heard and the opening appeared to be tightly closed. The method employed was simple and effective.

After the sutures were tied over gauze (Fig. 3) it was realized that the lung had not been expanded enough to force air out of the pleural cavity. The pneumothorax was therefore reduced to a minimum by apiration through an intercostal space by using a large needle and a pulsing syringe. The incision was then closed in the usual way.

The patient was given a transfusion in the evening after operation and placed in an oxygen tent for 48 hours because of moderate dyspnea. After the second day convalescence was uneventful. A proteus infection was found in the bladder urine after operation but disappeared after a course of mandelic acid. A roentgenogram of the chest at the end of 15 days showed evidence of a little fluid at the base but no aspiration was necessary. The patient was discharged well with the exception of a small sinus in the upper angle of the wound at the site of the drain which soon healed.

Eighteen months after operation the patient was in excellent health and had gained 60 pounds.

The most common cause for opening into the pleura during exposure of the kidney is an abnormally low posterior insertion of the diaphragm below the twelfth rib. The next in frequency is a short twelfth rib, so that the incision for exposure of the kidney is made under the border of the eleventh rib and directly into the pleural cavity. The pleura is also opened at times during rib resections made to increase the exposure but the diaphragm is usually not injured in such instances. Unless a suppurative renal condition is present, injuries to both pleura and diaphragm incident to exposure are generally sutured without difficulty and if properly handled without mortality. Cabot has seen 2 patients in whom the pleura was injured at operation but the pneumothorax was not recognized until late in convalescence.

Injury to the pleura and diaphragm during actual mobilization and removal of the kidney is often more extensive than those made during incision and exposure. They are more inaccessible and may present a difficult surgical problem in closure.

Quinby states

In cases demanding a nephrectomy there is infrequently any found condition external to the kidney itself which make an accidental opening of the pleural cavity very difficult to avoid. Indeed such injury to the diaphragm

may occur in certain instances even under the most expert hand with the most skillful dissection even during an operation of the subcapsular type. This accident is most apt to arise when the perirenal tissue has been greatly infiltrated with inflammatory products thus fixing the kidney closely to its surroundings. An accidental rent in the diaphragm most often occurs while an endeavor is being made to deliver the upper pole.

Gaza has written on the dangers of nephrectomy in cicatricial paranephritis and advocates piecemeal removal of the kidney in such cases so as to avoid injury to the diaphragm.

Various methods have been employed by surgeons to close injuries in the pleura and diaphragm. Rathbun routinely employs fat transplants in placing his sutures. Hesse who collected 19 cases in which the diaphragm was deliberately resected because of invasion from renal tumors describes the method of Anshuetz who sutured the diaphragm directly to the liver. A method also employed by Oppel, Borchardt used lung to repair the opening in the diaphragm. Hesse reported a case in which a large defect exposed the pericardium. He used liver and lung to close the opening in the diaphragm. In his 10 collected cases of extensive defects in the diaphragm following nephrectomy for renal tumor Hesse states that button sutures were used in 6 to bring the margins together while in 3 cases portions of the abdominal wall were utilized. The thoracic wall was used in 1 case and the lung in 1. The liver was used in 4 cases. In 5 no data were given as to the method employed.

In our case it was impossible to approximate the diaphragmatic margins, but by means of traction sutures, which ran transpleurally and through the intercostal spaces and skin it was possible to pull the medial margin of the pleural and diaphragmatic defect out against the wall of the chest and to effect a tight closure. Maylard used transpleural sutures to fix the kidney in nephropexy. Since his first usage Moore, Foley and others have employed transpleural sutures in such cases without complications. It is therefore evident that there is no great danger in bringing sutures out transpleurally between the ribs and through the skin. Heuer in transplantation of the diaphragm in dogs has sutured the diaphragm to the intercostal muscles but such a method would not be effective in cases such as the one we have reported. In preparing to report our case we found in the literature that a method somewhat similar to that employed by us was used by Bryan in 1927 to anchor the diaphragm to the chest wall in a case in which there was complete evulsion of one sheath of the diaphragm. Through the intercostal approach the torn margin of the dia-

phragm was caught by sutures and tied outside. The patient died immediately after operation. No case similar to ours has been found in the literature.

#### CONCLUSIONS

Accidental injuries to the diaphragm and pleura are not infrequent occurrences during exposure of the kidney. Most of these are readily sutured and rarely cause serious complication, although reports of mortality from this simple accident have been made by Fronstein and others. More extensive injuries to the diaphragm incident to delivering the upper pole of the kidney in cases with marked perinephric adhesions and scar formation are rarely encountered, but when they do occur, the closure may present a difficult surgical problem. They have usually been packed with gauze, but such treatment is often followed by serious complications and should be avoided.

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- 1 BETTMAN *Am J Surg*, 1929, 6 449
- 2 BRYAN *Surg, Gynec & Obst*, 1927, 45 688
- 3 TOLEY *Arch Surg*, 1929, 18 1413
- 4 FRONSTEIN Quoted by Peirson and Staples, loc cit
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- 6 GOLDSTEIN *Surg, Gynec & Obst*, 1937, 65 512
- 7 HESSE *Beitr z klin Chir*, 1924, 132 215
- 8 HEUER, ANDRUS, and BELL *Ann Surg*, 1925, 81 273
- 9 MATHE *Calif & West Med*, 1928, 28 57
- 10 MAYLARD Quoted by Moore, loc cit
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- 13 PEIRSON and STAPLES *Urol & Cut Rev*, 1935, 39 843
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- 16 SCHOLL *Cabot's Modern Urology* 3d ed Philadelphia Lea & Febiger, 1936
- 17 TILTON and SCHROEDER *Med J & Rec*, 1929, 129 444

It then occurred that the large tear could be obliterated by drawing the diaphragm against the chest wall. The technique employed was as follows: Five mattress sutures of heavy chromic catgut were placed in the medial margin of the diaphragmatic opening. With a large curved cutting needle these sutures were carried across the diaphragmatic defect transpleurally and through the intercostal muscles of the tenth and eleventh ribs (Fig. 3) and brought out through the skin. When they were pulled taut we could feel the medial margin of the diaphragmatic defect shift laterally until it was brought tightly against the chest wall. No further sucking noise was heard and the opening appeared to be tightly closed. The method employed was simple and effective.

After the sutures were tied over gauze (Fig. 3) it was realized that the lung had not been expanded enough to force air out of the pleural cavity. The pneumothorax was therefore reduced to a minimum by aspiration through an intercostal space by using a large needle and aspirating syringe. The incision was then closed in the usual way.

The patient was given a transthyronin in the evening after operation and placed in an oxygen tent for 45 hours because of moderate dyspnea. After the second day convalescence was uneventful. A proteus infection was found in the bladder urine after operation but it disappeared after a course of mandelic acid. A roentgenogram of the chest at the end of 15 days showed evidence of a little fluid at the base but no aspiration was necessary. The patient was discharged well with the exception of a small sinus in the upper angle of the wound at the site of the drain which soon healed.

Eighteen months after operation the patient was in excellent health and had gained 60 pounds.

The most common cause for opening into the pleura during exposure of the kidney is an abnormally low posterior insertion of the diaphragm below the twelfth rib. The next in frequency is a short twelfth rib, so that the incision for exposure of the kidney is made under the border of the eleventh rib and directly into the pleural cavity. The pleura is also opened at times during rib resections made to increase the exposure but the diaphragm is usually not injured in such instances. Unless a suppurative renal condition is present injuries to both pleura and diaphragm incident to exposure are generally sutured without difficulty and if properly handled without mortality. Cabot has seen 2 patients in whom the pleura was injured at operation but the pneumothorax was not recognized until late in convalescence.

Injury to the pleura and diaphragm during actual mobilization and removal of the kidney is often more extensive than those made during incision and exposure. They are more inaccessible and may present a difficult surgical problem in closure.

Quinby states

In cases demanding nephrectomy there not infrequently are found conditions external to the kidney itself which make an accidental opening of the pleural cavity very difficult to avoid. Indeed such injury to the diaphragm

may occur in certain instances even under the most expert hand with the most skillful dissection even during an operation of the subcapsular type. This accident is most apt to arise when the perirenal tissue has been greatly infiltrated with inflammatory products thus fixing the kidney closely to its surroundings. An accidental rent in the diaphragm most often occurs while an endeavor is being made to deliver the upper pole.

Gaza has written on the dangers of nephrectomy in cicatricial paranephritis and advocates piecemeal removal of the kidney in such cases so as to avoid injury to the diaphragm.

Various methods have been employed by surgeons to close injuries in the pleura and diaphragm. Rathbun routinely employs fat transplants in placing his sutures. Hesse who collected 19 cases in which the diaphragm was deliberately resected because of invasion from renal tumors describes the method of Anshuetz who sutured the diaphragm directly to the liver. A method also employed by Oppel, Borchardt used lung to repair the opening in the diaphragm. Hesse reported a case in which a large defect exposed the pericardium. He used liver and lung to close the opening in the diaphragm. In his 19 collected cases of extensive defects in the diaphragm following nephrectomy for renal tumor Hesse states that button sutures were used in 6 to bring the margins together while in 3 cases portions of the abdominal wall were utilized. The thoracic wall was used in 1 case and the lung in 1. The liver was used in 4 cases. In 5 no data were given as to the method employed.

In our case it was impossible to approximate the diaphragmatic margins but by means of traction sutures, which ran transpleurally and through the intercostal spaces and skin it was possible to pull the medial margin of the pleural and diaphragmatic defect out against the wall of the chest and to effect a tight closure. Maylard used transpleural sutures to fix the kidney in nephropexy. Since his first usage Moore, Foley, and others have employed transpleural sutures in such cases without complications. It is therefore evident that there is no great danger in bringing sutures out transpleurally between the ribs and through the skin. However in transplantation of the diaphragm in dogs has sutured the diaphragm to the intercostal muscles but such a method would not be effective in cases such as the one we have reported. In preparing to report our case we found in the literature that a method somewhat similar to that employed by us was used by Bryan in 1927 to anchor the diaphragm to the chest wall in a case in which there was complete evulsion of one sheath of the diaphragm. Through the intercostal approach the torn margin of the dia-



Fig 3

Fig 3 Photomicrograph of the tumor mass. Note the dense fibrillar appearance of the lesion and in one area a spicule of bone.

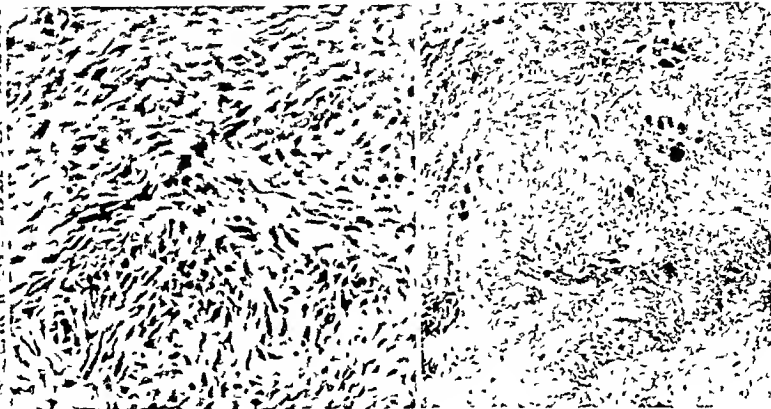


Fig 4

Fig 4 Photomicrograph showing scattered groups of giant cells of the osteoclast type in the dense fibrillar stroma.

centimeter was removed with the motor saw. It was rounded at its distal end by a rasp, and its proximal end was coned. The coned end was placed into the previously prepared funnel of the metacarpal stump, and the distal end was articulated with the proximal phalanx. The outer envelope was sutured over the graft and the areolar tissue carefully approximated around the extensor tendons. The skin was approximated with black, waxed silk. A plaster cast was applied with the middle finger slightly hyperextended.

The report from the pathology laboratory follows. The specimen, S 905-36, consists of a metacarpal bone transformed into a tumor mass 5 by 3 by 2 centimeters. It is firm and encapsulated, the distal end is smooth and the proximal end is roughened (Fig 2). On sectioning, the mass presents a uniform, grayish-white tissue. Microscopic examination revealed a tumor consisting of a dense fibrillar connective tissue (Fig 3) which in places shows metaplasia into osteoid tissue and bone (Fig 4). There are groups of multinucleated giant cells of osteoclast type (Fig 5) which are sometimes related to spicules of bone. The histological picture is distinctly different from a giant cell tumor in which the dense connective tissue is not encountered. A

diagnosis of dense fibroma with focal areas of osteoid metaplasia was made.

The wound healed by primary intention, and the patient was discharged from the hospital on March 7, 1936. The cast was removed on the twenty-eighth day and physical therapy, consisting of whirlpool, massage, and active and gentle passive exercises, was instituted.

The patient made an uneventful recovery with almost complete return of both form and function. The length of the finger was restored (Figs 6, 7, 8). Roentgenograms taken May 14, 1936 (Fig 6), 92 days after operation, show the early restoration, those (Fig 9) taken May 16, 1938, approximately 27 months after operation, show the transformation of the graft into a true metacarpal bone with notched head, neck, cortex, and marrow cavity formation, and the photographs (Fig 10) show the appearance and range of motion at this time.

Fibromas of bone are extremely rare and when so diagnosed frequently prove to be fibrosarcomas. Geschickter and Lewis state that "most of the

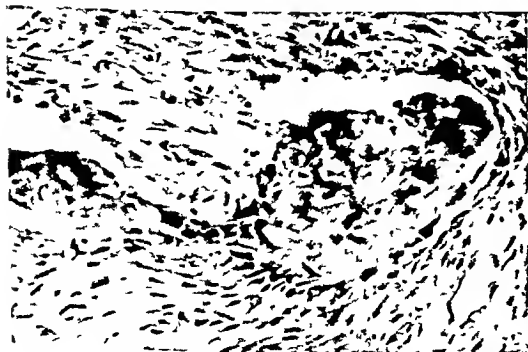


Fig 5 Photomicrograph showing metaplasia of fibrillar tissue into osteoid tissue and bone.

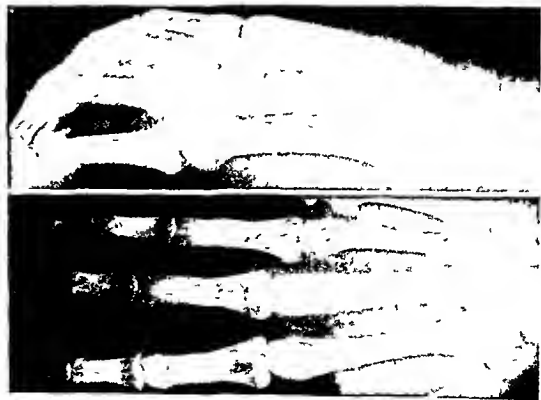


Fig 6 Roentgenogram showing reconstruction of metacarpal by tibial graft. Note restored length of the finger.

# FIBROMA OF THE MIDDLE METACARPAL BONE

## Resection and Reconstruction

DANIEL H. LEVINTHAL, M.D., F.A.C.S., and JACK D. KIRSHBAUM, M.D., M.S.  
Chicago, Illinois

**T**HIS rather unusual lesion of the metacarpal bone is presented because of its peculiar histopathological picture, radiological diagnostic difficulties and the unique reconstruction with an almost perfect end result.

The patient, a white female, 16 years of age, born in Italy, was admitted to the orthopedic service February 11, 1936, from the outpatient clinic. The past history, general physical examination, and serological examination were all negative. The complaint was a progressive swelling of the dorsum and palm of the right hand which was first noticed about a year prior to her admission to the Cook County Hospital. The local examination showed shortening of the middle finger of the right hand and a fusiform swelling about the size of a large walnut in the region of the middle metacarpal bone extending into the palm and on the dorsum. There was only a moderate limitation of motion of the middle finger due to the palmar swelling, but there was no associated pain except on pressure.

The roentgenogram showed a lytic expanding tumor of the middle metacarpal bone with absence of cortex along parts of the shaft (Fig. 1). The base of the metacarpal for about 1 centimeter appeared uninvolved. There was a tiny

crest of bone just beneath the distal articular surface. The rest of the shaft was completely destroyed. This middle metacarpal was shorter than the two adjacent ones. The pre-operative diagnosis was benign giant cell tumor.

**Operation.** On February 12, 1936, the right hand and left leg having been prepared previously in routine manner, the following operation was performed. Under general anesthesia and with a blood pressure cuff as a tourniquet, a longitudinal incision was made on the dorsum of the hand over the mass. The extensor tendons were gently retracted and the outer capsule of the tumor mass was incised. By careful dissection, the entire mass, including the head of the metacarpal, was freed from its bed and separated from the apparently normal proximal tunic, meter which was allowed to remain *in situ*. This proximal stump was funneled. From the left tibia, a graft 7 by 1

From the Departments of Orthopedic Surgery and Pathology, Cook County Hospital.

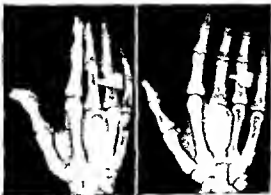


Fig. 1. Roentgenogram before operation showing expanding lytic tumor of the middle metacarpal bone. Complete destruction of the shaft including cortex, some trabeculation. There is a thin remnant of bone of fairly normal density in the subchondral region of the head of the metacarpal and about 1 centimeter of normal appearing bone at the proximal end. Note the shortening of the metacarpal.



Fig. 2. Photograph of the gross specimen showing (A) cut surface, (B) the external aspect with some capsular layers, (C) roentgenogram of the specimen. Note the bony trabeculae.

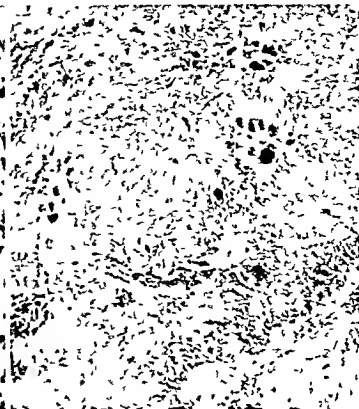
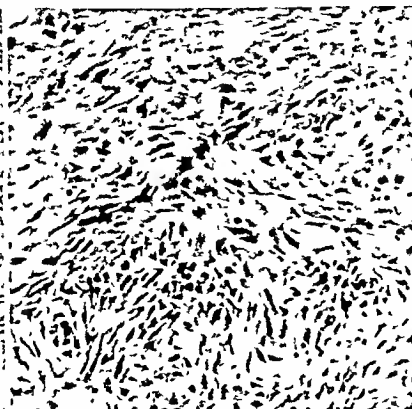


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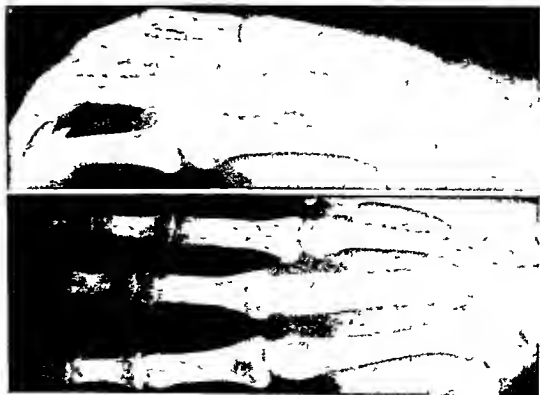


Fig 6 Roentgenogram showing reconstruction of metacarpal by tibial graft. Note restored length of the finger.



Fig. 7 Photographs taken 6 months after operation showing range of motion. The upper photograph shows the scar on the dorsum. The lower photograph shows very moderate limitation of flexion.



Fig. 9 Roentgenographic appearance 27 months after operation showing transformation of graft into a true metacarpal bone. Note restoration of head neck cortex and medulla.

fibroma found in long bones may follow trauma. (2) Our case may be considered a sclerosing type of giant cell tumor. But against the diagnosis of a giant cell tumor is the lack of cellularity of the stroma and the absence of hemorrhage and young blood vessels. On the other hand Geschickter (3) believes that giant cell tumors of the small bones may show an unusual amount of reactive fibrosis and osteoid material. However our experience in a careful study of all benign giant cell tumors encountered in our laboratory has been different in that we have never observed such a diffuse and dense fibrosis as in the case here reported. It was the opinion of the late Dr. R. H. Jaffe that the lesion was that of a benign fibroma and not a sclerosing giant cell tumor.



Fig. 8 Photographs showing extension and flexion. Note restored length of the finger.



Fig. 10 Photographs 27 months after operation showing restored length of right middle finger full extension and very moderate limitation of flexion.

The roentgenogram of the tumor suggests a consideration of the differential diagnosis between enchondroma, myxochondrosarcoma, sarcomatous degeneration of a giant-cell tumor, in addition to benign giant-cell tumor and fibroma.

Heretofore lesions of this type were treated by a total extirpation of the metacarpal and the appended finger with a resultant three fingered hand.

#### SUMMARY AND CONCLUSION

A very unusual fibroma of the metacarpal bone, with resection and reconstruction is here described.

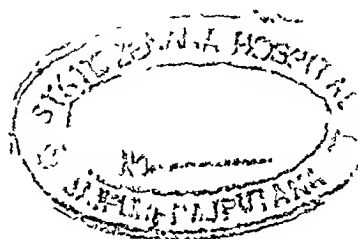
The case is also of interest because of the

diagnostic difficulties of the lesion, and the complete functional results obtained following surgery. The viability of an autogenous bone graft is proved. Its transformation into a metacarpal bone, in contour and internal construction, is apparent.

The similarity of benign fibromas and sclerosing giant-cell tumors is discussed.

#### BIBLIOGRAPHY

1. GESCHICKTER, C. F., and LEWIS, DEAN. Tumors of connective tissue. *Am J Cancer*, 1935, 25: 641.
2. GESCHICKTER and COPELAND. Textbook—Tumors of Bone. Revised ed 1936, published by American Journal of Cancer, p. 719.
3. GESCHICKTER. Personal communication.





# A NEW AND SAFER METHOD OF CITRATED BLOOD TRANSFUSION

Professor A. HUSTIN and A. DUMONT M.D. Brussels Belgium

AMERICA has always remained faithful, even more so than Europe, to the citrate method of blood transfusion, ever since one of the above authors (2) advocated this method for the first time 25 years ago.

This method of blood transfusion has been attacked as having 2 major disadvantages: (1) the blood used loses an important part of its properties; (2) the method is likely to produce more frequent and grave reactions than that involving pure blood. The work of numerous research scientists has eliminated the first objection. It has been demonstrated that citrate alters neither the structure nor the functions of the globules and does in no way diminish the immunizing properties of the plasma.

Many statistics have been produced to prove that accidents due to blood transfusions occur more often (15 to 20 per cent) in the transfusion of citrated blood than that of undiluted blood (10 to 12 per cent). However, our experience gathered from the Centre de Transfusion des Hôpitaux de Bruxelles, has convinced us that the majority of these accidents were caused by defective technique rather than the method itself. In perfecting this technique we have been able to reduce the accidents from 12 to 3 per cent.

The following will set forth several details on the facts observed and will present a description of the technique employed.

During the year 1937, 85 liters of blood were transfused into 253 patients. Three different methods were successively utilized: (1) the transfusion of pure blood, (2) citrated blood transfusion, and (3) the transfusion of citrated blood as in the second method but with a definitely improved technique.

The transfusion of undiluted blood was performed by means of an apparatus based on the "milking" principle (the French apparatus of Henry and Jouvelet is analogous to that of the American de Bakey).<sup>1</sup>

Eighty-four cases were treated with this method and necessitated 26 liters of blood or 307 cubic centimeters per patient. Notwithstanding the apparent simplicity of the devices based on

the "milking" principle serious difficulties often presented themselves. In 7 cases, the transfusion was interrupted (8.4 per cent), in more than 20 cases, the vein of the donor, or of the receiver or of both had to be punctured several times. In 3 cases, air bubbles were introduced into the blood circulation by not staunching the tube connection of the needle of the donor. The reactions which occurred as a result of these transfusions numbered 6 or 9.5 per cent, 2 of which were serious.

The second method using citrated blood, was employed in 76 cases. This blood was collected by means of a newly tried contrivance. About 30 liters of blood were withdrawn and re-injected, or, on the average of 385 cubic centimeters per operation. The withdrawal of blood was interrupted 3 times, occasionally though not repeatedly, the vein had to be punctured more than once. Much of the blood used had been preserved in a refrigerator for several days before having been re-employed. The most careful inspections were made for the least trace of blood clots. Actually a few clots were found in 19 of the test tubes or in one quarter of the cases. Reactions occurred in 7 cases, one of which was serious, or in about 9.2 per cent.

We now come to our third and last classification. In these blood transfusions, the same method as in the preceding was utilized. However it was definitely improved and perfected. Thirty-three liters of blood were drawn from 18 donors on an average of 420 cubic centimeters from each and 31 of these liters were re-injected into 93 patients, averaging 330 cubic centimeters for each receiver. Of the original 33 liters of blood collected 6 were used as therapeutic measures on hypertensive patients.

Twice the withdrawal of blood failed. Only once were blood clots observed in the preserved blood and that blood came from a polycythemic individual whose blood was particularly coagulable. The accidents which arose in using this method amounted to 4, twice to the same patient because of agranulocytosis which occurred at the sixth and eighth transfusions, once to a patient suffering from hemothorax and once in a serious case of hemarthrosis of the knee. Thus reactions occurred in 5.4 per cent of the cases in which this

<sup>1</sup>Since this paper was written one of us (Hustin) achieved a transfusion pump much simpler than that of de Bakey also based on the milking principle. This pump is represented in Figs. 4 and 5.

method was used and were of the mildest variety. If, to the transfusions during 1937, in which this method was utilized, are added those made in January 1938, the percentage of reactions does not exceed 3 per cent.

The comparison between the cases of the second and third classifications, seems to show that the more the chances of coagulation during the collection of the blood are reduced, the more the gravity of transfusional accidents will be diminished. This leads us to the conclusion that many of these reactions are due to the formation of blood clots in the blood withdrawn.

Clots do not cause transfusional reactions by acting as emboli, as in our experience they were always eliminated by a careful filtration of the blood containing them. However, they are dangerous because of toxic substances released from their mass. From certain experiments made on animals, it was shown that the addition of fibrin extracts to the reinjected blood often results in grave symptoms. This opinion is corroborated by the observations of Petroff and of Kasumov. They bring out the fact that the injection of preserved and filtrated blood, having once contained blood clots, causes vomiting, fever, leucocytosis, etc.

It is also probable that a number of the reactions observed after the use of pure blood are due to the presence of blood clots formed in the needle after injection into the vein of the donor. This opinion has been acquired in the course of numerous collections of blood made with the aid of our own apparatus.

The latter has been constructed so that it is possible to note continually the least change in the flow of blood from the needle. Very often, even under the most favorable conditions, this flow diminishes considerably when about 200 cubic centimeters of blood have been withdrawn.

It has been found that this slackening does not occur if the needle is frequently washed with a citrate solution, thus, the only explanation seems to be that blood clots form on the sides of the needle.

Having been convinced of the toxic rôle played by the clots, or, rather by the factors causing their formation, the next step was to try to reduce the frequency of coagulation. This was brought about with some success by the citration of the blood from the very moment it left the needle, and also, of course, a careful washing of the needle at frequent intervals.

However, another important factor undoubtedly had much to do with the improvement in our results. This was the care taken to avoid injuring

the globules in the process of introducing the citrate into the collected blood. With the technique in general use, the blood and the anticoagulant mixture are mixed together rather forcefully by means of a glass stirring rod. In the course of this action, the globules of the blood, especially the platelets, are greatly damaged and react to such violence by secreting toxic substances.

Freund has shown that a suspension of platelets in a citrated solution can be injected into cats without producing a reaction. But if the same suspension is previously shaken by means of several beads, violent vasomotor reactions are caused. Undoubtedly it is the same substance derived from the platelets which make the blood toxic, as it is well known that the globules play but a primary rôle in the coagulation of the blood.

In every transfusion, there is the danger of accidents proceeding from 2 different sources. The first of these may be the incompatibility of the blood drawn. In such cases reactions occur immediately during the re-injection into the receiver and cause cyanosis, palpitation of the heart, heat flushes, pain in the lumbar region, etc. The other types of accident are those caused by the liberation of toxic substances by the platelets and the blood clots. The reactions from this type come some time after the transfusion and occur in the form of chill, fever, urticaria, edema, and erythema.

#### PROCEDURE

The following is the authors' procedure, which they have followed for almost 6 months, and which has given excellent results.

The apparatus, illustrated in the diagram, consists of the following. A 500 cubic centimeter graduated glass container, provided with a rubber stopper, pierced in 3 places for the insertion of 3 glass tubes labeled *a*, *b*, and *m*. The tubule which is connected to the wider tube *a*, or the canalization of entry, is inserted in the bottle so that it barely extends further than the neck. Externorly, it is bent at a right angle, close to the stopper. The tubule of tube *b*, has the same diameter as that of *a*, but in contrast to that of *a* reaches almost to the bottom of the bottle. This will be designated by the term canalization of outlet. Thus, the internal orifice of the tubule of *a*, is inserted in such a manner that the blood passes directly from the tubule to the bottom of the container without the slightest dribbling against the vertical stem of the tubule of *b*, or against the walls of the bottle itself.

The third canalization *m*, is of smaller diameter than the 2 others. The purpose of this canalization is to allow air out of the glass container when

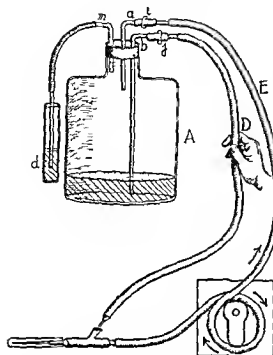


Fig. 1. Diagram of the apparatus illustrating the principle of the method of citration of the blood in the needle.

blood comes in the bottle. It is extended externally by fine rubber tubing. To the rubber tubing is joined a glass tube which is plunged into a test tube half full of sterile water *d*. A piece of adhesive tape keeps it braced to the bottle. The size of the end of this tube is such that when 1 cubic centimeter of blood enters the glass container a bubble is drawn out by the tube. Thus the intake of the container can be controlled instantaneously by the outflow of air bubbles into the test tube.

Tubes *a* and *b* are both extended outside of the bottle by small rubber joining devices or unions whose other extremities are connected to very narrow glass tubes. On these rubber devices are placed Mohr clips labeled 1 and 2.

In addition the apparatus has two rubber tubes 50 centimeters in length and with resistant walls joined one to the inflowing tube *b* and the other to the outflowing tube *E*, the transfusion apparatus of Henry and Jouvet or that of de Bakey and a needle having 2 projections ending in openings. The needle has bevelled edges and the diameter of the interior is eight tenths millimeters. The needle has 2 openings, the one in direct continuation has the same interior diameter as

the rubber tube, the other placed laterally has a smaller caliber (Record). The point of the needle may be closed by a hermetic cover.

**Sterilization.** Fifty cubic centimeters of 5 per cent sodium citrate is poured into the glass container which is carefully closed with the stopper. The incoming and outgoing tubules are attached by joining devices described to the rubber tubes. Their ends are protected by wads of gauze. The whole apparatus is covered with a cloth and is sterilized in the autoclave.

**Preparation.** The glass container and its accessories are taken out of the protecting cloth. The aspirating tube, *E*, is placed in the Henry and Jouvet apparatus and the two ends of the rubber tubes are attached to the projections from the needle. Because of the difference in sizes of the two projections, one can be sure that the ingoing tube will be joined to the main projection and the outgoing tube to the smaller one. Several cubic centimeters of sterile water are poured into the test tube *d*, attached to the glass container. The needle has been carefully recovered with its hood so that by operating the Henry and Jouvet apparatus all the tubes are filled with the citrate solution. The liquid can be seen rising into the outgoing tube but soon falls back again from the incoming tube. During this action, no air bubbles rise to the level of the lateral tube *m*.

The equipment for the donor is completed by the use of the Paëhon pneumatic wristband as a tourniquet. This is kept inflated under minimum pressure during the entire operation. Thus, conditions are created which produce the largest possible outflow of blood from the donor.

**Collection of the blood.** The needle is taken from its protective hood. The handle is given a half turn in a direction opposite to its normal direction. The citrated liquid flows out of the needle and, in so doing, leaves it filled with the anti-coagulant liquid.

Next the rubber tube *D* running from the lateral projection of the needle is disconnected and the vein is punctured. Blood rises to the lateral projection. The connection between the rubber tube and the lateral projection is reestablished. The handle is turned and bloody liquid can be seen falling to the bottom of the glass container from the inflowing tube *a* and then rising again into the outflowing tubule of *b*. At the same time large bubbles of air leave the test tube. Thus we can be sure of the progressive filling of the glass container. The latter is shaken gently from time to time, to insure the thorough mixing together of the blood and the citrated fluid. At regular intervals, the outflowing tube *D* is cut off

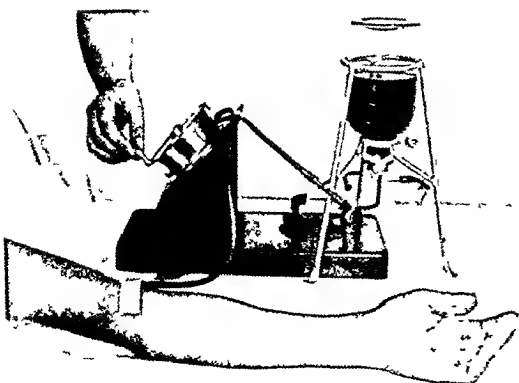


Fig 2 Collecting the blood

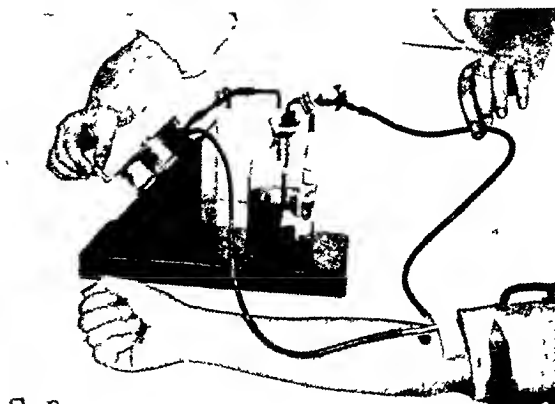


Fig 3 Reinjection of the blood to recipient

The handle of the pump is turned two or three times in the direction opposite to normal. A small amount of citrated blood is thus driven back into the vein of the donor while at the same time, the passage in the needle is washed. As this goes on, the receiving tubule *a*, empties itself of the bloody mixture it contains. After the needle is washed, the connection with tube *D* is resumed and the process of suction continues.

What happens during these processes?

It can easily be seen that the Henry and Jouvet apparatus produces a suction of venous blood at the level of the needle, and a suction of citrated solution through the lateral projection. The mixture of these two liquids very near the point of the needle, imparts a quality of stability to the blood which has just been drawn from the vein. Thus, at the very beginning of the process the venous blood is diluted with the pure citrate solution. Afterward, however, strongly citrated blood from the glass container is substituted.

The proportions of blood and citrate solution used depend upon several factors, particularly the size of the needle and its lateral projection, and the blood pressure of the vein. In practice, the size of the needle and of its lateral projection has been calculated in such a manner that for a venous pressure of from 8 to 10 cubic centimeters of mercury, blood and the anticoagulant liquid must be used in the proportions 2 to 1. This proportion can be varied during the process of collection, by varying the degree of constriction of the outflowing tube. If the tube is completely closed off, only pure blood is secured, but if it is contracted less, the quantity of pure blood collected, diminishes. The proportion of the two constituents can be noted from the number of air bubbles leaving the bottle by the reagent tube. Thus, when pure

blood is collected, a bubble of air can be seen forming at each turn of the pump's handle. However, should the mixture contain two parts blood to one part of the citrated liquid, the handle must be turned three times in order to produce two air bubbles. In this way the operator is constantly kept informed as to the functioning of the apparatus and also as to the permeability of the needle. Any obstruction in the latter, even partial, immediately brings about a diminution in the number of air bubbles in proportion to the turns of the handle.

The technique described permits the easy collection of a huge quantity of blood by only one puncture of the vein. The collection can also be accelerated, if desired, by completely shutting off the outgoing tube. In this case, pure blood alone, is temporarily collected.

The procedure is as follows: during thirty turns of the handle, the outflowing tube is closed by the fingers. It is then opened again for ten turns of the handle. After that, the needle is washed by making three turns in the opposite direction, taking care that the outgoing tube is again closed off. Thanks to this little device, a half liter of blood can be collected from most of the donors within 10 minutes.

*Finishing the collection.* When the desired quantity of blood has been obtained, the needle is withdrawn from the vein and is covered with its stophood. Then, several more turns of the handle, in the natural direction are made in order to fill the tubes with citrated blood and to mix the fluid in the glass container.

The removal of about 40 cubic centimeters of blood which remains in the tubes is accomplished by simply turning the Henry and Jouvet apparatus backward until several bubbles of air form

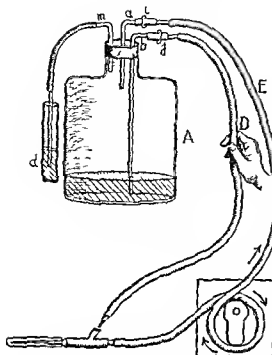


Fig. 7. Diagram of the apparatus illustrating the principle of the method of citration of the blood in the needle.

blood comes in the bottle. It is extended externally by fine rubber tubing. To the rubber tubing is joined a glass tube which is plunged into a test tube half full of sterile water, *d*. A piece of adhesive tape keeps it braced to the bottle. The size of the end of this tube is such that when 1 cubic centimeter of blood enters the glass container a bubble is drawn out by the tube. Thus the intake of the container can be controlled instantaneously by the outflow of air bubbles into the test tube.

Tubes *a* and *b* are both extended outside of the bottle, by small rubber joining devices, or unions, whose other extremities are connected to very narrow glass tubes. On these rubber devices are placed Mohr clips labeled *i* and *j*.

In addition the apparatus has two rubber tubes 50 centimeters in length and with resistant walls joined one to the inflowing tube *b* and the other to the outflowing tube *E* the transfusion apparatus of Henry and Jouvelet or that of de Bakley and a needle having 2 projections ending in openings. The needle has bevelled edges and the diameter of the interior is eight tenths millimeters. The needle has 2 openings, the one in direct continuation has the same interior diameter as

the rubber tube the other placed laterally has a smaller caliber (Record). The point of the needle may be closed by a hermetic cover.

**Sterilization.** Fifty cubic centimeters of 5 per cent sodium citrate is poured into the glass container which is carefully closed with the stopper. The incoming and outgoing tubules are attached by joining devices described to the rubber tubes. Their ends are protected by wads of gauze. The whole apparatus is covered with a cloth and is sterilized in the autoclave.

**Preparation.** The glass container and its accessories are taken out of the protecting cloth. The aspirating tube *E*, is placed in the Henry and Jouvelet apparatus and the two ends of the rubber tubes are attached to the projections from the needle. Because of the difference in sizes of the two projections one can be sure that the "going" tube will be joined to the main projection, and the outgoing tube to the smaller one. Several cubic centimeters of sterile water are poured into the test tube, *d*, attached to the glass container. The needle has been carefully recovered with its hood so that by operating the Henry and Jouvelet apparatus, all the tubes are filled with the citrate solution. The liquid can be seen rising into the outgoing tube but soon falls back again from the incoming tube. During this action no air bubbles rise to the level of the lateral tube *m*.

The equipment for the donor is completed by the use of the Pachon pneumatic wristband as a tourniquet. This is kept inflated under minimum pressure, during the entire operation. Thus conditions are created which produce the largest possible outflow of blood from the donor.

**Collection of the blood.** The needle is taken from its protective hood. The handle is given a half turn in a direction opposite to its normal direction. The citrated liquid flows out of the needle and in so doing leaves it filled with the anti-coagulant liquid.

Next the rubber tube *D* running from the lateral projection of the needle is disconnected and the vein is punctured. Blood rises to the lateral projection. The connection between the rubber tube and the lateral projection is reestablished. The handle is turned and bloody liquid can be seen falling to the bottom of the glass container from the inflowing tube *a* and then rising again into the outflowing tubule of *b*. At the same time large bubbles of air leave the test tube. Thus we can be sure of the progressive filling of the glass container. The latter is shaken gently from time to time to insure the thorough mixing together of the blood and the citrated fluid. At regular intervals the outflowing tube *D* is cut off

fessional donors This has resulted in quite a saving for the center

Our method has made possible a saving of almost 25 per cent in the use of professional donors Each time 450 cubic centimeters of blood has been withdrawn from them It has been observed that this rather large drain has been withstood very well, in fact, patients recovered practically as they would have done from a much less severe loss of blood in a direct transfusion

A bottle containing 500 cubic centimeters of citrated blood will supply the amount necessary

for several cases An amount as small as 50 cubic centimeters can be withdrawn from the bottle provided the precaution is taken to filter the air that enters the bottle, the residue in the bottle will then remain aseptic

#### BIBLIOGRAPHY

- 1 FREUND In: Die Gefaesserweiternde Stoffe der Gewebe aus Sanguetierblut By J H Gaddum, p 85
- 2 HUSTIN, A Nouvelle méthode de transfusion Bull Soc roy d sc méd et nat de Brux, 1914, April, No 4
- 3 PETROFF and KASUMOV Arch f klin Chir, 187 668

## THE EFFECT OF LIPIODOL IN THE SUBARACHNOID SPACE

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**D**URING the past few years there has been a great increase in the use of lipiodol in the spinal canal, chiefly as a result of the increasing attention directed toward the syndrome arising from dislocations of the intervertebral discs and enlargement of the ligamentum flavum In most instances, a final diagnosis in these conditions requires careful fluoroscopic study following the injection of lipiodol into the lumbar subarachnoid space

Recently we had an opportunity to make a careful study of the contents of the spinal canal in a patient who had had lipiodol injected 6 months previously Little recent comment has been made on the effects of lipiodol in the spinal canal and there is a surprising scarcity of pathological studies on human nerve structures subsequent to the use of this substance In fact, following the admonitions of Craig in 1929 and the experimental studies of Davis, Haven, and Stone in 1930, we found little in the English literature until the report by Globus in 1937 It seems to us worthwhile, therefore, to review briefly the literature on this subject

Sicard and Forestier began the use of lipiodol as a diagnostic aid in 1922 Since that time, they have used it for a variety of purposes, including its injection into the subarachnoid spaces It has remained their conviction that the oil is in no way harmful to the nerve elements in the spinal canal

In 1924, Ayer and Mixter reported experimental results on the effects of iodized oil in the spinal subarachnoid system in cats Their animals showed an increase in the cell count of the spinal fluid and 1 death resulted in the 6 animals studied Sicard and Forestier, at a later time, commented on the fact that the amount of lipiodol used by Ayer and Mixter was excessive for the size of the animals and was in no way comparable to the amount used in human beings

Klose and Peiper, in 1925, reported that clinically they had seen transient headaches and root pains but, after 2 years' observation, had encountered no other ill effects They also made some experimental observations on rabbits and reported pathological changes in the ganglion cells in which the Nissl bodies were clubbed and pale The contents of the cells stained poorly and the sharp outline was lost There were also changes around the central canal, characterized by necrosis of the tissue and a wall of leucocytes next to this necrotic layer

In the same year, Krause reported a case of tumor of the spinal cord in which increased pain followed the injection of lipiodol At operation he described a marked redness and injection of the nerve roots which he had not previously encountered and which he attributed to the oil He commented further on a case of Egas Moni, in which increased cell count, more pain, and a temporary increase in paraplegia occurred after injection The primary pathological process was not mentioned

on top of the contents in the bottle. This shows that all the tubes have been completely emptied.

Mohr clips are placed on the small rubber joining devices on the outgoing and ingoing tubes and on the rubber tube used for the evacuation of the air. Then all three tubes are detached from the glass container. The latter is stirred gently to insure the homogeneity of its contents and then placed in the refrigerator.

**Reinjection.** After having carefully stirred the blood again to insure its homogeneity, the bottle is placed neck downward in a tripod supporting apparatus. The rubber connection at the end of the receiving tube, is removed and replaced by a rubber pipe which passes into a Henry and Jouvet *let apparatus*.

The Mohr clip is removed from the outflowing tube. The cannulations are filled with blood by one or two turns of the handle. The receiver's vein is entered and the projection of the needle is joined to the small outlet at the end of the rubber tube. By manipulating the handle of the pump the speed with which the blood enters can be regulated to that desired. Only a part of the contents of the bottle may be injected. If care has been taken to filter the air entering the bottle by means of cotton wadding the remainder of the contents may be used for another patient. Before reinjection one must make sure that the receiving tube is level with the stopper. Thus the last drop of blood of the container can be used.

The apparatus of Henry and Jouvet may be replaced by a blast of thermocautery that can be attached to the end of the outflowing tubing.

#### THE ADVANTAGES OF THE APPARATUS

The apparatus described seems to the authors to have all the desired qualities combined with a maximum of simplicity.

The bottle, having a capacity of 500 cubic centimeters sufficient for the withdrawal of a maximum amount of blood is used for all the steps in the process: the collection, preservation and reinjection of the blood. The sodium citrate is introduced before the bottle is sterilized. The bottle is sterilized and is provided with the tubing when it is ready for use. When the blood has been collected the only preparation necessary before transfer to the refrigerator is the closing of three clips. Thus the liquid is kept constantly in a rigorously sterile environment, so that all chances of contamination are eliminated.

The collection of the blood is made in a circuit entirely citrated so that coagulation is eliminated. The blood drawn from the vein and the citrate are mixed in a projection from the needle itself.

The supply of citrated fluid can be regulated to the quantity desired.

At a moment's notice, the needle itself can be cleansed with a minimum amount of preparation by means of the anticoagulant liquid. The use of the Pachen pneumatic wristband slightly inflated puts the donor in the best possible conditions for the withdrawal of blood. Finally, the device for the evacuation of air, adapted to the glass container, shows how rapidly the blood is being collected and permits the operator to watch the progress of the operation and to modify it when necessary. The apparatus of Henry and Jouvet or of de Bakely provides a simple and adjustable method of motorizing the circuit. The quantity of citrate liquid and the quantity of blood to be withdrawn can be easily proportioned. By a few turns of the handle the excess citrated fluid can be evacuated *beforehand*.

All these conditions make possible the facile collection of a large quantity of blood (450 cubic centimeters) without coagulation and within an extremely short space of time.

The technique of reinjection is greatly facilitated by the use of the tripod support. By overturning the bottle the contents can be used even to the last drop. By inserting a filter to cleanse the air, only part of the blood contained in the bottle need be used at one time. Therefore, the contents of the bottle can be used in a series of transfusions in large or small amounts as needed.

At the transfusion center of Krugmann Hospital the authors have succeeded in making by this method more than 150 collections of blood. At each collection blood to the amount of 450 cubic centimeters has been withdrawn so that a much larger number of reinjections than with draws have been made. The authors have found the device fully satisfactory.

Thanks to the system of co operation between the different departments of the hospital all phlebotomies for therapeutic purposes are done in the transfusion center. Here, by means of the technique described the operation is accomplished swiftly, cleanly and with the least disturbing effect on the patient. The quantity of blood withdrawn corresponds exactly to the requirements of the attending physician. The blood so obtained is preserved in a refrigerator. The blood group to which the accidental donor belongs is immediately determined. The qualities of the blood are analyzed and a Wassermann test is performed. If the analyses show that the blood is satisfactory it is used for reinjection. It has been possible in more than one-fourth of the transfusions performed to use blood so obtained instead of blood from pro-

reaction with malaise, sluggishness, and loss of appetite. These symptoms disappeared in from 24 to 48 hours in all but 1, and that animal died in 3 days. One other animal developed spasticity of 1 hind leg a week after injection, which lasted 6 months. Pathological studies showed a leptomeningitis with accumulations of large mononuclear and plasma cells. No organisms were found. Fat substances and inert matter were seen as inclusions in the macrophages. Van Gieson's stain showed enlarged vessels and thickening of their walls in the anterior aspect of the cord. Encysted fat was found in the leptomeninges. The ganglion cells in the anterior horns, especially in the cervicodorsal area, were decreased to about one-half of normal. The rest of the cells in that region were shrunken and irregular. The cell processes stained indistinctly or not at all, the nuclei were dimly stained and, in many, cells were eccentric and occasionally absent. The cytoplasm of the shrunken cells was either excessively stained or not at all. The vascularity of the anterior horns was increased with many new capillaries, and vessels of the anterior half were often thrombosed. The posterior horns showed no change. Davis, Haven, and Stone concluded that the use of lipiodol was attended by some danger of damage to the nervous system.

In 1931, Lindblom (15) conducted further experimental studies with rabbits and concluded that there was considerable variation in the susceptibility of individual animals of the same type to iodized oil. His experiments further led him to the conclusion that irritation of the nerve structures was directly proportionate to the amount of free fatty acid in the oil used. The same type of oil, with varying degrees of acidity, produced varying degrees of irritation, increasing as the free acid content was raised. He reported changes over the cortex in rabbits 6 months after injection showing some pachymeningitis with encysted oil in the leptomeninges. He advised careful use of the oil.

Bruskin and Propper, in 1931 reported changes occurring from 2 to 3 months after the injection of lipiodol in dogs. Pathological studies showed a proliferative reaction in the meninges of the cerebrum and cord where the preparation had come to rest. There were some small extravasations of blood, especially in the gray matter of the spinal cord, and degeneration of cells was noted in the spinal roots. These authors concluded that lipiodol caused changes in the spinal cord both by its chemical action and by behaving as a foreign body.

Fumarola and Enderle, 1932, reported 26 cases of myelography with lipiodol. In 6 cases there was some febrile and meningeal reaction with increased pain, and motor and sensory disturbance. They reported 1 death after myelography and believed that the lipiodol produced a mechanical and chemical irritation. They also stressed the importance of the relation between acidity and the irritative effect.

In spite of these various experimental and clinical reports, however, Sicard and Forestier, in 1932, completely exonerated lipiodol of any harmful effects in the human subarachnoid system.

Donat, in 1937, reported the case of a patient with metastatic sarcoma involving the brain. Lipiodol had previously been injected in the spinal canal with an increase in the amount of pain. The patient died 1 month later and examination of the spinal cord revealed chronic inflammatory changes in the leptomeninges with some blood in the pia arachnoid. Peripherally, the spinal cord showed areas of degeneration. The axis cylinders stained poorly and showed a granular dissolution with general detachment at the periphery of the white substance. Donat believed that the changes were caused by the lipiodol, except the bleeding which he considered secondary to the meningitis.

In contrast, Globus reported, in 1937, 138 cases in which lipiodol had been used. Only 2 patients had a relatively severe immediate reaction, but rapidly recovered. A few had transient headaches and slightly increased pain temporarily. The condition of 65 patients was checked after several years—10 years in 1 instance. Only 1 patient had any complaint that might be referred to lipiodol, namely, increased pain in the back. Roentgenographic examinations were made of 34 of these patients. There was no appreciable reduction in the amount of the lipiodol and it moved freely. Three patients who subsequently died were examined at autopsy. Globus reported that no evidence of leptomeningitis was found, though no further pathological details were given. He concluded that lipiodol is entirely safe as a diagnostic aid in man.

One would conclude from the various reports that, in animals, there is evidence to indicate that lipiodol may produce not only irritative changes, but permanent alteration in the leptomeninges, spinal cord, and nerve roots. Clinically, many of these animals seemed entirely normal in spite of the pathological findings described. Sicard and Forestier pointed out that, in the majority of animal experiments, the amount of



In this country, Maclaire in 1915, described a case in which both cisternal and lumbar injections of lipiodol had been made in a patient with injury to the cord from kyphosis. His operative report mentioned thickening of the dura and the arachnoid which were left open after operation. Re-operation because of increased symptoms, revealed dense leptomeningeal and meningomyelitic adhesions and two arachnoidal cysts containing lipiodol. The patient became progressively worse. Maclaire attributed the bad results to lipiodol and advised against its use apparently overlooking the original pathological process as well as the natural sequence of changes following laminectomy without closure of the dura. This report drew further comment from Sicard and Forestier in defense of lipiodol, as well as in criticism of Maclaire's failure to analyze properly the various factors concerned.

In 1916 Wartenberg reported a case in which respiratory difficulty and unconsciousness followed the injection of lipiodol by both cisternal and lumbar routes. The symptoms cleared when the head was elevated. Later, metastatic carcinoma of the spine was found at autopsy.

In the same year, Sharpe and Peterson reported 3 cases in which the symptoms increased following the use of lipiodol. These were not entirely convincing for 2 of the patients apparently suffered from a progressive disorder of the nervous system in which an increase in symptoms was to be expected and 1 patient had a painful amputation stump and later developed pain in the opposite leg.

Faugh and Mella also in 1920 reported on 13 patients with a variety of disorders of the nervous system, in whom 2 cubic centimeters of lipiodol had been injected in the basal cistern. Aside from transient pain in the leg in 4, a slight rise in temperature in 3 and nausea and headache in 1, they observed no ill effects.

Lindblom, in 1920 (14) injected lipiodol in rabbits and produced a clinical picture resembling meningitis, which cleared in 2 weeks. Histological studies showed a sterile leptomeningitis characterized by leucocytes and lymphocytes in abundance in the meninges wherever iodized oil was located. After from 2 to 3 weeks, only single leucocytes and lymphocytes and plasma cells were present. After months no changes could be seen in spite of the fact that iodized oil could still be demonstrated in large quantities in the meninges.

Birgerhoff in 1927 reported a case in which there was encapsulation of the iodized oil by many adhesions of connective tissue appearing,

as if a compression myelitis were present at the site.

Nonne, in the following year reported his experiences in a great number of myelographies done with iodized oil. He recorded a rather frequent increase in symptoms with regard to pain and motor, sensory, and sphincter disturbances though again the injection was done frequently in patients with progressive disease of the nervous system. He reported 1 case of chronic meningitic compression of the spinal cord. Lipiodol was subsequently injected and, at postmortem 4 weeks later, was found to have penetrated into the spinal cord. Microscopic study revealed active glial proliferation around the centrally located lipiodol.

Schochauer, in 1919, reported the case of a patient who had pachymeningitis hemorrhagica interna. The ascending type of lipiodol was injected and this patient subsequently died of meningitis.

Globus and Strauss also in 1920 reported 5 cases in which lipiodol had remained in the spinal canal for over 2 years. They stated that repeated neurological examinations were negative and that the lipiodol remained free and without adhesions. Only 1 patient, who had a tumor of the spinal cord, showed transient symptoms of increased pain. These authors concluded that the oil was entirely without ill effects and could be used safely.

In the same year Elsberg stated that in his experience the oil acted as a distinct irritant to the meninges. At operation he observed nerve roots which were congested and inflamed, and there were similar changes in the pia. In his opinion however permanent effects occurred only occasionally.

Further warning came from Craig in 1929, against the indiscriminate use of lipiodol in view of the temporary irritative effect which it produced in experimental animals. He advised particularly against its use in inflammatory conditions. The thought came to mind that in 1 case in which the condition was considered to be inflammation and pain was increased after the injection of lipiodol a diagnosis of dislocated intervertebral disc might be made today.

Dr. J. Haven and Stone carried on further experimental work on 10 dogs. An artificial block was produced in the spinal canal by laminectomy and insertion of a rubber dam. Later 1.5 cubic centimeters of lipiodol was introduced in the basal cistern. Another group of dogs served as controls. The animals were killed in from 3 to 22 days. Eight showed clinical evidence of irritative

reaction with malaise, sluggishness, and loss of appetite. These symptoms disappeared in from 24 to 48 hours in all but 1, and that animal died in 3 days. One other animal developed spasticity of 1 hind leg a week after injection, which lasted 6 months. Pathological studies showed a leptomeningitis with accumulations of large mononuclear and plasma cells. No organisms were found. Fat substances and inert matter were seen as inclusions in the macrophages. Van Gieson's stain showed enlarged vessels and thickening of their walls in the anterior aspect of the cord. Encysted fat was found in the leptomeninges. The ganglion cells in the anterior horns, especially in the cervicodorsal area, were decreased to about one-half of normal. The rest of the cells in that region were shrunken and irregular. The cell processes stained indistinctly or not at all, the nuclei were dimly stained and, in many, cells were eccentric and occasionally absent. The cytoplasm of the shrunken cells was either excessively stained or not at all. The vascularity of the anterior horns was increased with many new capillaries, and vessels of the anterior half were often thrombosed. The posterior horns showed no change. Davis, Haven, and Stone concluded that the use of lipiodol was attended by some danger of damage to the nervous system.

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Fig 1



Fig 2



Fig 3

Fig 1. Normal lipiodol shadow in the lower thoracic region showing the unity of the globule of oil.

Fig 2. Normal lipiodol shadow in the lumbar region showing the unity of the globule of oil.

Fig 3. Roentgenogram of the spine 6 months after the injection of lipiodol showing the diffusion and encroachment of the globules of oil throughout the lumbar subarachnoid space.

lipiodol used is much greater, in proportion, than that used in human beings. In addition there is a difference between animals and man in their susceptibility to the oil, another factor which renders comparison difficult.

The observations made on human beings are difficult to evaluate. Many of the studies have been made on patients with progressive disease of the nervous system and it is impossible to place on lipiodol the responsibility of subsequently increasing symptoms. The reports of irritative phenomena seen at operation are unquestionable, but it is difficult to tell whether these phenomena are only temporary or whether they produce permanent changes in the nervous system. Again it is hardly fair to attribute all the pathological processes found at operation to the presence of lipiodol and disregard the cause for which the operation is being done, particularly if a second stage operation is performed.

Pathological studies on human beings after the use of lipiodol are few. Donat recorded marked changes in the cord of a patient dying from sarcoma but did not indicate the part played by the wasting disease either directly or in regard to the patient's susceptibility to the oil. Globus reporting three autopsy studies in

which there was no evidence of leptomeningitis, gave no description of pathological changes.

Such a review leaves one in much doubt as to the facts with regard to the effect of lipiodol in the spinal subarachnoid system in man.

#### CASE REPORT

The following case report is made, not with the idea that it will solve our problem but merely to offer additional information on a subject which in recent years has been rather neglected.

H. D., a man 35 years of age fell from a haystack on February 13, 1931, and fractured the tenth and twelfth thoracic vertebrae. A plaster cast was applied. There was temporary numbness in the left leg which soon cleared. Residual periodic pain and paresthesia persisted in the left leg. After the removal of the cast a radiation of pain developed around the area of the tenth and eleventh roots on the right side. Paravertebral injection of the nerve roots with novocain gave temporary relief. On August 15, 1937, 4 cubic centimeters of lipiodol was injected and roentgenograms showed a normal spinal canal in the thoracic and lumbar regions. The only complaint following the use of lipiodol was a temporary increase in discomfort over the sacrum and buttocks but this disappeared in 2 or 3 weeks. The symptoms in the left leg gradually subsided several months after lipiodol had been injected. Due to persistent pain referable to the tenth and eleventh dorsal roots a hemilaminectomy was done some 6 months after the injection of lipiodol and some encroachment on the intervertebral foramen by a displaced pedicle was found.

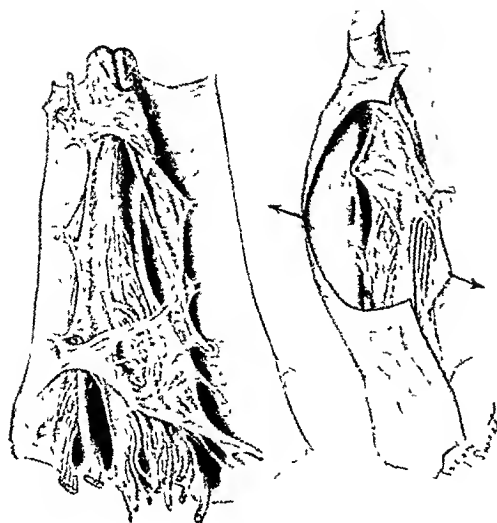


Fig 4 Drawing showing adhesions about the lower part of the cord and the cauda equina

with traction on the 2 involved roots. A fusion was done following the laminectomy. Nitrous oxide anesthesia, followed by ether, was used. The patient's breathing was poor throughout and his color dusky. The anesthetic was stopped at 10 30 a m, but the patient did not recover consciousness, and died at 6 30 p m the same day.

The roentgenograms taken immediately following the introduction of the oil showed the smooth canal and the

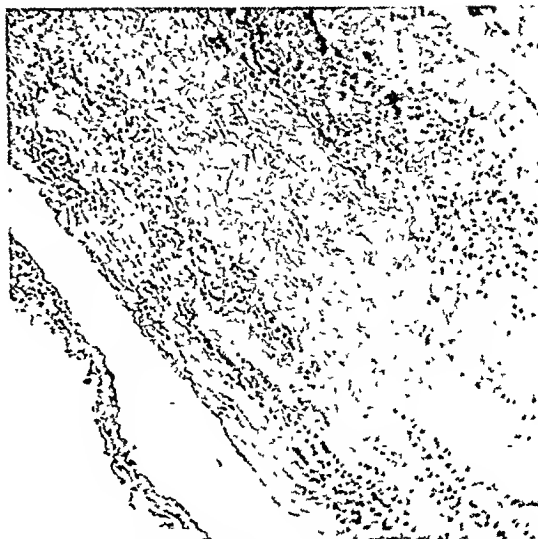


Fig 6 Photomicrograph showing thickened dura, with lymphocytic infiltration

unity of the globule of oil (Figs 1 and 2). Those taken on the day of his death, however (6 months after the injection of lipiodol), showed the oil to be strung out and caught in small globules throughout the subarachnoid space (Fig 3).

*Autopsy report.* The findings were essentially normal and irrelevant to this paper except for the pathological changes in the central nervous system. For this reason the general protocol is omitted.



Fig 5 Photomicrograph of the adhesions between the cord and the dura

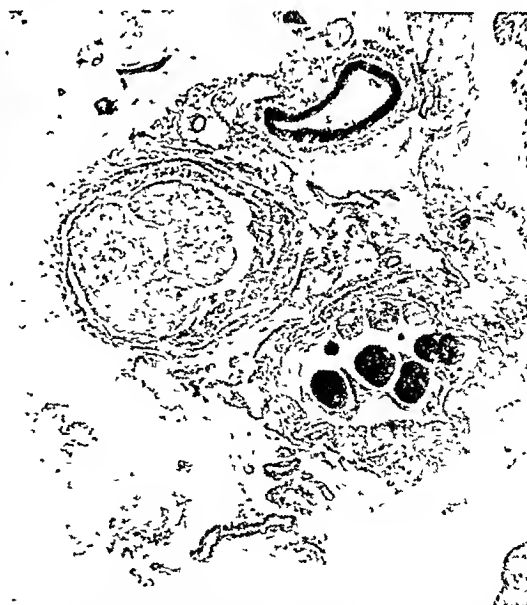


Fig 7 Photomicrograph showing adhesions about the spinal nerves

On examination of the central nervous system the brain was found to be edematous weighing 1550 grams. It measured 13 by 16 by 12 centimeters and the convolutions were somewhat flat from edema. There was no sclerosis at the base of the brain and the leptomeninges were normal. Sections through the brain showed normal symmetrical undilated ventricles lined with smooth ependymal membrane and there were no gross pathological changes in the cerebellum or stem.

The spinal cord in the upper thoracic portion and in the area of recent operation showed considerable congestion and edema on the surface. Beginning at the level of the first lumbar vertebra and extending down around and over the cauda equina were numerous very fine filmy adhesions which ran throughout the leptomeninges and onto the surface of the spinal cord proper. These fine adhesions enveloped the cord and extended down along the dorsal and ventral nerve roots into and almost through the dura (Fig. 4). Only a few fine droplets of oil were seen enmeshed in these adhesions which were all old. Grossly there was no evidence of old blood pigment either staining the under surface of the dura in the adhesions mentioned above or in the leptomeninges proper and there was no evidence of recent infection.

*Microscopic description.* The brain was very edematous. The leptomeninges also showed moderate edema. The ependymal linings were smooth and normal. There were open spaces about the pyramidal cells which showed a little early postmortem degeneration.

Sections of the spinal cord above the level of the twelfth thoracic showed a normal dura and a pia arachnoid in which the vessels were congested but in which there was no cellular infiltration or evidence of old inflammation or repair. The structure of the spinal cord was normal and there was no visible change in the ganglion cells either in the anterior or the posterior horns, no chromatolysis and no definite changes in the axis cylinders or myelin sheaths. Sections taken below the level of the twelfth thoracic vertebra however showed numerous fine filmy fibrous adhesions running from the surface of the cord throughout the leptomeninges and into the dura. The dura was very definitely thickened and many lymphocytes were found both in the leptomeninges in the adhesions and in the inner part of the dura (Figs. 5 and 6). Fibrous adhesions ran out along, and invested the spinal nerves and in these adhesions all lymphocytes were lightly scattered (Fig. 7). After frozen sections fat stains showed tiny droplets of oil in the adhesions described. In these areas however there was no evidence of old blood pigment or other foreign material which would act as a stimulating substance.

From the findings at autopsy, a diagnosis of chronic pachymeningitis of the lower dorsal cord and cauda equina was made and the changes in the meninges of the lower cord were ascribed to the irritating action of the lipiodol which had been held there for approximately 6 months.

While such a proliferative reaction in the lower portion of the spinal cord could take place subsequent to old bleeding in this area it is felt that the absence of old blood pigment both in the dura and pia arachnoid reasonably excludes former bleeding as a cause of the adhesions. On the other hand the presence of droplets of oil in the fine fibrous mesh and their localization to a dependent portion of the spinal cord indicate that this proliferative reaction and chronic inflammatory change occurred subsequent to the presence of the lipiodol in this region. As far as can be determined microscopically and in correlation with the history these adhesions had caused no appreciable symptoms but owing particularly to their position about the nerve roots any contraction in the ensuing years might have resulted in symptoms from compression in these

areas. Inasmuch as the operations for laminectomy and spinal fusion were done on the day of death they were in a chronological sense exonerated from any contribution to these pathological development.

#### SUMMARY AND CONCLUSIONS

A considerable diversity of opinion now exists as to the effect of lipiodol upon the nervous elements of the spinal canal. The bulk of evidence indicates that both gross and microscopic pathological changes may occur in the nervous system following injection of iodized oil into the subarachnoid space. There is no doubting the permanency of the oil in the spinal canal for there is very little evidence of absorption after several years. It is equally true that the oil frequently becomes encysted and adherent in the arachnoid and along the nerve roots as was demonstrated in this case. The clinical symptoms which such changes may produce are neither definite nor specifically characteristic and in this particular case in spite of the adhesive changes present no persistent subjective complaint or objective neurological finding appeared which might have been attributed to the oil. Undoubtedly arachnoid adhesions of considerable degree such as those occurring after laminectomy, may exist without clinical symptoms. In one of our recent cases a lumbar laminectomy was done on a patient to relieve compression of the nerve by an enlarged ligamentum flavum. Reoperation a year later, to obliterate a false meningocele revealed marked adherence of the roots of the cauda equina to the dura with numerous arachnoid adhesions but the patient's only complaint had been that of headache upon flexion of the spine or local pressure over the operative site. This symptom disappeared following obliteration of the meningocele. There were no subjective complaints or objective findings referable to the adherent nerve roots.

Nevertheless the use of any substance which may produce such changes in the nervous system cannot be regarded as entirely harmless and while lipiodol is an extremely valuable diagnostic aid in the localization of intraspinal lesions in carefully selected cases its indiscriminate use should not be encouraged.

#### REFERENCES

1. WEE J. H. and MIXER W. J. Radiography following the injection of iodopon into the spinal subarachnoid space. *Arch. Neurol. & Psychiat.* 1924 33: 499-500.
2. HACHINGER W. Harmful effects of iodopon injections in roentgen examinations. *Fortschr. a. d. Geb. d. Roentgenstrahlen* 1927 36: 374.

- 3 BRUSKIN, J, and PROPPER, N Experimental myelencephalography on dogs, influence of iodopin and lipiodol on the spinal cord, brain, and meninges *Ztschr f d ges exper Med*, 1931, 75 34-55
- 4 CRAIG, W MCK The use and abuse of iodized oil in the diagnosis of lesions of the spinal cord. *Surg, Gynec & Obst*, 1929, 49 17-28
- 5 DAVIS, L, HAVEN, H A, and STONE, T T The effect of injections of iodized oil in the spinal subarachnoid space *J Am M Ass*, 1930, 94 772-777
- 6 DONAT, R Injuries to the spinal cord following diagnostic myelography *Deutsche Ztschr f d ges gerichtl Med*, 1937, 29 34-45
- 7 EBAUGH, F G, and MELLA, H Lipiodol in the localization of spinal lesions II The local and systemic effects of the injection of lipiodol into the subarachnoid space *Am J M Sc*, 1926, 172 117-123
- 8 ELSBERG, C A Tumors of the spinal cord, problems in their diagnosis and localization, procedures for their exposure and removal *Arch Neurol & Psychiat*, 1929, 22 949-965
- 9 FUMAROLA, G, and ENDERLE, C Dangers, disadvantages, and injuries in myelography with iodized oils *Radiol Med*, 1932, 19 1271-1284
- 10 GLOBUS, J H, and STRAUSS, I Intraspinal iodology, subarachnoid injection of iodized oil as an aid in detection and localization of lesions compressing the spinal cord *Arch Neurol & Psychiat*, 1929, 21 1331-1386
- 11 GLOBUS, J H Contribution made by roentgenographic evidence after the injection of iodized oil *Arch Neurol & Psychiat*, 1937, 37 1077-1082
- 12 KLOSE, H, and PEIPER, H Myelography *Arch f klin Chir*, 1925, 134 303-387
- 13 KRAUSE, F (Discussion) *Zentralbl f d ges Neurol u Psychiat*, 1925, 41 924
- 14 LINDBLOM, A P Effect of lipiodol on the meninges *Acta Radiol*, 1926, 5 129-134
- 15 Idem On the effects of various iodized oils on the meninges *Acta med Scandinav*, 1931, 76 395-402
- 16 LUCHERINI, T Diagnostic value of spinal canal roentgenography after injection of lipiodol, method of removal of lipiodol from spinal sac *Policlin. (sez prat)*, 1936, 43 575-584
- 17 MACLAIRE, A S Lipiodol in neurosurgery, with a report of a case with deleterious results *Am J M. Sc*, 1925, 170 874-880
- 18 NONNE, M. Kritische Bemerkungen zur Jodipin Diagnostik bei Rueckenmarkserkrankungen *Deutsche Ztschr f Nervenhe*, 1928, 102 6-13
- 19 SCHOENBAUER, L Die Ergebnisse der operativen Behandlung de Rueckenmarkstumoren *Arch f. klin Chir*, 1929, 154 645-692
- 20 SHARPE, W, and PETERSON, C A The danger in the use of lipiodol in the diagnosis of obstructive lesions in the spinal canal *Ann Surg*, 1926, 83 32-41
- 21 SICARD, J A, and FORESTIER, J The Use of Lipiodol in Diagnosis and Treatment, a clinical and radiological survey New York and London Oxford Press, 1932
- 22 WARTENBERG, ROBERT Beitrage zur Encephalographie und Myelographie *Arch f Psychiat*, 1926, 77 507-531

On examination of the central nervous system the brain was found to be edematous weighing 1550 grams. It measured 17 by 16 by 12 centimeters and the convolutions were somewhat flat from edema. There was no sclerosis at the base of the brain and the leptomeninges were normal. Sections through the brain showed normal symmetrical undilated ventricles lined with smooth ependymal membrane and there were no gross pathological changes in the cerebellum or stem.

The spinal cord in the upper thoracic portion and in the area of recent operation showed considerable congestion and edema on the surface. Beginning at the level of the first lumbar vertebra and extending down around and over the cauda equina were numerous very fine filmy adhesions which ran throughout the leptomeninges and onto the surface of the spinal cord proper. These fine adhesions enveloped the cord and extended down along the dorsal and ventral nerve roots into and almost through the dura (Fig. 4). Only a few fine droplets of oil were seen encased in these adhesions which were all old. Grossly there was no evidence of old blood pigment either staining the under surface of the dura in the adhesions mentioned above or in the leptomeninges proper and there was no evidence of recent infection.

*Microscopic description.* The brain was very edematous. The leptomeninges also showed moderate edema. The ependymal linings were smooth and normal. There were open spaces about the pyramidal cells which showed a little early postmortem degeneration.

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#### REFERENCES

1. ASKE J. B. and MCELROY W. J. Radiography following the injection of iodopon into the spinal subarachnoid space. *Arch. Neurol. & Psychiat.* 1934 31: 499-509.
2. BRUNENHOFF W. Harmful effect of iodopon injections in roentgen examinations. *Fortschr. u. Geb. d. Röntgenstrahlen* 1927 30: 374.

TABLE I—CASES OF CARCINOMA OF BARTHOLIN'S GLAND

Author	Age	Previous evidence of glandular infection	Operation	Type of growth	Metastasis to inguinal glands	Result
1 Kelly	55	None	Incised and later excised	Adenocarcinoma	*	*
2 Eden	40	None	Radical removal of gland and part of pubic ramus	Adenocarcinoma	Enlarged	No re-occurrence in 3 yrs
3 Spencer	43	None	Excision with inguinal glands	Adenocarcinoma	Not enlarged	No re-occurrence in 22 mos
4 Lynch	43	None	Removal of inguinal and vaginal metastases	Squamous	Metastasis to brain and inguinal nodes	Death 2½ years later
5 Martin (3)	70	None	Removal with glands	*	Inguinal nodes enlarged	Recovered in 4 yrs
6 Geist	50	None	Removal of tumor	Adenocarcinoma	None	*
7 Schweizer	58	Chronic infection 3 yrs	Refused	Carcinoma parvicellular	None	*
8 Machenrodt	54	None	Removal of tumor	*	None	No re-occurrence in 4 mos
9 Honan (3)	40	Discharging sinus 1 yr	Removal of tumor	*	Opposite inguinal gland	No re-occurrence in 2 mos
10 Godart	40	None	*	*	*	*
11 Trotta	30	None	Removal of tumor	Chancroid carcinoma	None	No re-occurrence in 6 yrs
12 R. Schaffner	73	None	Removal of tumor	Adenocarcinoma	Inguinal glands enlarged	Re-occurred in 2 yrs
13 Burghle	50	None	*	Adenocarcinoma	*	Re-occurrence in 6 mos
14 Sitzenfrey	29	Bilateral chronic glandular infection	Removal of tumor with thermocautery	Adenocarcinoma	None	Re-occurrence in 6 mos
15 Pape	91	None	Removal of tumor	Adenocarcinoma	None	*
16 O. V. Frisch	77	None	Removal of tumor with local anesthesia	Adenocarcinoma	Inguinal nodes enlarged	*
17 Falk	39	Previous chronic glandular infection	Removal with left inguinal gland	Adenocarcinoma	None	No re-occurrence in 14 mos
18 Casler (3)	*	*	*	Adenocarcinoma	*	*
19 Sin (22)	*	*	*	Melanocarcinoma	*	*
20 Taussig	43	*	Two stage Basset procedure, 2 wks later cautery excision	Squamous	Inguinal glands enlarged	No re-occurrence in 14 mos
21 C. V. Hunt	36	None	Excision followed by 13,386 mg hr radium	Adenocarcinoma	Not enlarged	No re-occurrence in 2 yrs
22 L. D. Powell (3)	71	None	Radical removal	Squamous	*	*
23 Rabinovich	71	None	Excision of tumor	Adenocarcinoma	Not enlarged	*
24 Harer	33	None	Excision of tumor with 1200 mg hr radium	Adenocarcinoma	Not enlarged	No re-occurrence in 3 mos
25 Strauss (2 cases)	61	None	Excision with 1200 mg hr of radium plus x-ray therapy	Anaplastic carcinoma	Not enlarged	No re-occurrence in 1 yr
26	48	None	Two stage Basset procedure 2 weeks excision	Squamous	Not enlarged	No re-occurrence in 1 yr
27 Lyle	30	*	Endothermic vulvectomy	Adenocarcinoma	*	No re-occurrence in 2 yrs
28 Healy (reported by Lyle)	*	*	*	3 Cases adenocarcinoma	*	*
29 C. W. Mayo and Barber (3 cases)	36	*	Partial excision	Adenocarcinoma	*	Re-occurrence after 7 yrs
30	41	*	Radium therapy	Adenocarcinoma	*	No re-occurrence after 2 yrs
31	50	*	Excision and x-ray therapy to inguinal glands	Squamous	Right inguinal gland involved	No re-occurrence after 3 mos
32 Schneider (3)	*	*	*	Adenocarcinoma	*	*
33 Grynfeltt and Godlewski	*	*	*	Squamous	*	*
34 P. E. Hoffman	*	None	*	Squamous	*	*
35 O. Margaretti	63	*	Radical excision of mass plus lymphatic glands	Squamous	Inguinal glands enlarged	*
36 E. A. Simendinger	74	None	X-ray therapy followed by complete vulvectomy	Squamous	Not enlarged	No re-occurrence in 8 mos

\*Information lacking.



# CARCINOMA OF BARTHOLIN'S GLAND

## Report of a Case of Squamous Cell Epithelioma

E A SIMENDINGER A B, M D Cincinnati Ohio

UP to the present time there have been only 38 cases of primary carcinoma of Bartholin's gland reported, and of these adenocarcinoma has been the predominant type, only 9 have been squamous cell carcinomas.

Probably the first case reported was that of Kolb (8) in 1864. Sin recorded a case in 1880 followed by Geist in 1887, Schweitzer and Machenrodt in 1893, O V Frisch in 1904 and Sitzenfrey in 1906 all of whom reported similar cases. H R Spencer reviewed the literature in 1913 collecting 15 cases reported to that date one of which was a squamous cell carcinoma. In 1923, F H Falls collected 20 cases, 12 of which were adenocarcinoma, 1 a squamous cell epithelioma, and 7 undiagnosed as to type. Since then similar cases have been reported by Hunt and Powell in 1926, Schneider in 1930, J Rabinovich in 1932, Harer, H Strauss, C W Mayo and Barber in 1933, H H M Lyle in 1934, Grynfeldt and Godlinski in 1936, P E Hoffman and O Margarucci in 1937. There were only 3 cases of carcinoma of Bartholin's gland found in a review of cases at The Mayo Clinic from July 1923 to July, 1933, according to C W Mayo and Barber.

In 1923 F H Falls presented, in graph form the cases he had found. Using a similar graph I have added 18 cases reported since that date up to March, 1938.

### REVIEW OF THE LITERATURE

In a review of cases reported it was found that the ages of the patients varied between 29 and 91 years. The average age was 51.0 years in 30 cases reported in which the age of the patient was given. The majority of cases occurred between the ages of 40 and 55 years.

Infection is apparently not a predisposing factor in neoplasms of Bartholin's gland as in only 2 cases those of Sitzenfrey and Falls was there a past history of infection. Chronic infections of the gland are quite common and often lead to mistakes in diagnosis as in many cases an early

neoplasm was thought to be a chronic infection of the gland.

Hereditry is not an important factor according to Harer who was able to find only 2 cases in which there was a family history of carcinoma. In only 1 case was there a definite history of trauma to the gland however the glands undoubtedly must be the site of frequent trauma. Harer reports that the condition is commonly found in married women, and may occur in unmarried women but never in virgins.

Carcinoma of Bartholin's gland is usually first noticed as a small hard painless, nodular swelling lying deep in the labial fat. The lesion is usually quite movable at first but sooner or later enlarges according to the degree of malignancy, and becomes attached to the surrounding tissues. The skin is usually not involved until late so that when the tumor is first noticed the skin is freely movable over it. With enlargement of the tumor pain develops which is commonly referred to the coccyx and groin and is made worse by coitus and menstruation. Pain is usually the symptom which causes the patient to seek medical attention and by this time the tumor is usually quite well established. As the skin becomes involved the tumor becomes painful to the touch, and the skin red, dened and edematous. It is common for parts of the growth to become necrotic and semi fluctuant, thus giving one the impression of cyst of the gland. This is more common in rapidly growing neoplasms. Sooner or later the growth involves the skin either of the vulva or vagina and when the skin is destroyed the tumor becomes secondarily infected, giving rise to a chronic discharging sinus. The mass tends to grow deep rather than superficial involving the surrounding fat muscle tissue and later the pubic bones.

The most important points in diagnosis are the age of incidence, hardness of the tumor with tendency toward fixation, pain and later edema of the vulva, failure to respond to treatment and a biopsy.

According to Falls one must bear in mind in differential diagnosis that chronic infections of the gland are apt to undergo regressions in size and are most frequently bilateral. Carcinomas

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Fig 1 Low power photomicrograph showing sheets of wildly growing epithelial cells in the center of which degeneration is taking place. There is a marked increase in fibrous tissue with many collections of lymphoid cells scattered through it  $\times 5$

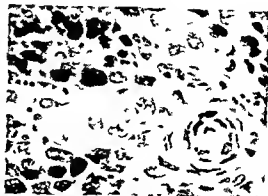


Fig 2 High power photomicrograph showing early pearl formation and cell structure found generally throughout the tumor  $\times 340$

of the skin of this region are always squamous, while those of Bartholin's gland are predominantly adenomatous. Sarcomas are found in younger individuals and show a mesoblastic cell on biopsy. Benign tumors are slow in growth and do not invade or metastasize. Gonorrheal infections are diagnosed by an acute course, the history and a positive smear. Carcinomas arising from the vulvar skin involve it primarily, while those arising from Bartholin's gland involve the skin late.

There are 2 types of carcinoma of Bartholin's gland possible: the squamous cell epithelioma and the adenocarcinoma. This is possible according to Rabinovich because the acini of the gland and deeper parts of the ducts are lined by 2 distinct types of cells, the columnar and the cuboidal, while the superficial ducts are lined with squamous epithelium. Carcinomas of these superficial ducts are squamous, while those of the gland acini are adenomatous. Sitzenfrey believes that the transitional and columnar epithelium, which lines the deeper portions of the ducts, may by a process of metaplasia become squamous in the presence of chronic infection, thus giving rise to squamous cell carcinomas.

Most authors agree that carcinoma of Bartholin's gland like other vulvar carcinomas metastasizes early. Metastasis most frequently occurs in the inguinal nodes of the same or of the opposite side. Lynch reported a case in which cerebral metastasis occurred. Involvement of the penoscrotum of the ramus of the pubis occurs early and by direct extension. There have been no reported cases of bilateral involvement of the glands.

Prognosis in carcinoma of Bartholin's gland is unfavorable. The almost uniform failure of early diagnosis is the most important factor in the poor prognosis. According to Taussig carcinoma of Bartholin's gland is almost uniformly fatal as contrasted with the exsting type of vulvar carcinomas arising from vulvar leucoplacia. Rabinovich believes that early the tumor is encapsulated and if the neoplasm be excised before the stage of encapsulation has passed prognosis will be good. In 21 cases reported in which information is available there was no recurrence in 1 case in 6 years, in 1 case in 4 years, in 5 cases in 2 years, and in 4 cases in 1 year, 5 cases recurred and 5 cases were recorded too early after removal of the growth to make any lack of recurrence of value.

In the minds of most authors the proper therapy of carcinoma of Bartholin's gland is a combination of radiation and surgery. Taussig advises a Basset's procedure with removal of the inguinal glands followed in 2 weeks by excision of the tumor by cautery. Strauss reports that at Radiumhemmet in Stockholm good results have been obtained from electrocoagulation and radiotherapy. Kelly advises endothermic vulvectomy and electrocoagulation of the glands *in situ*.

Lyle states that epitheliomas of Bartholin's gland are as radioresistant as vulvar epitheliomas and advises wide excision of the vulva and secondary dissection of the inguinal and femoral glands followed by regional and local radiation. Removal of the inguinal and femoral gland followed closely by endothermic removal of the tumor mass with preoperative and postoperative irradiation is perhaps the most suitable form of therapy.

## CASE REPORT

Case No 75712 Mrs D B, a white woman, aged 74 years, married, was admitted to the gynecological service of the Cincinnati General Hospital on June 11, 1937, with a complaint of "painful lump between my legs." The patient had suffered from a cardiac ailment for the past 10 years, but otherwise she felt well until approximately December 25, 1936. At that time she noticed a small, hard, painless lump about 1 by 1.5 centimeters in size located deep in the posterior portion of the left labium, which was quite hard and fixed in position. She could recall no history of injury to the part but thought injury was probably the cause.

About the middle of April, 1937, approximately 4 months after she first noticed the growth, she began to have aching pains in the region of the tumor which radiated to the groin and low back. The mass during the 4 months had increased to approximately 4 by 4 centimeters in size. During the same period there appeared another mass the size of a golf ball posterior and lateral to the original tumor and closely approximated to it. The second mass was soft, fluctuant, and very tender. During the course of the ensuing 2 weeks it became quite large and about May 1, 1937, ruptured through the overlying skin, discharging about 200 cubic centimeters of a colorless, odorless, mucinous fluid. A small sinus formed at the point of rupture which failed to heal, and mucinous, later purulent, material constantly drained from it. The sinus, however, did not increase in size.

Approximately 5 months after the onset the patient first sought medical attention and was advised that she had an infected Bartholin's gland and that hot fomentations should be applied. This therapy was of no avail and by June 1, 1937, the mass had increased in size until it was about 5 by 6 centimeters in size and was very painful, rendering the patient bed fast and unable to use her left leg without pain. The overlying skin was swollen, red, and painful to palpation in the region of the tumor. Up until this time the vulvar skin had been quite healthy, non-tender, and freely movable over the hard nodular mass. On June 11, 1937, she was sent to the Cincinnati General Hospital for treatment. From December until June she had lost 10 pounds in weight and in the past 3 months had noticed gradually increasing, general weakness.

**Past history** The patient had suffered from arteriosclerotic heart disease for the past 10 years but with no history of decompensation. Five years ago she was admitted to a mental hospital and a vaginal examination at that time was negative. There was no past history of lues or gonorrhea. The family history was negative aside from the fact that her mother died of carcinoma of the breast. There was no other history of malignancy in the family. Two brothers were living and well.

**Menstrual history** Menses began at the age of 16, were regular each 28 days and lasted 4 days. She suffered with no menorrhagia or metrorrhagia, menopause occurred at the age of 40. There was no discharge except at menstrual periods. The patient had two children living and well and had had one miscarriage. There was no history of gonorrhea or lues.

**Physical examination** Blood pressure 220/110, pulse, 70, respiration, 22. The patient was a poorly developed, undernourished, senile, white woman. She was mentally clear, intelligent, and quite co-operative. On pelvic examination the left labium was found to be greatly enlarged and bulged over the introitus. No vaginal discharge was present. The skin over the left labium was injected, tender to the touch, and slightly edematous, but freely movable over a more deeply situated, hard, nodular mass. The mass was buried in the fatty tissues of this region, painful to

pressure, stony hard, fixed, and not well outlined. The surrounding tissues were slightly indurated except for a small area at the posterior portion of the mass which was soft, slightly fluctuant, and tender to palpation. There was a small draining sinus on the posterior inner portion of the left labium from which small amounts of purulent material drained, especially when pressure was exerted on the above described fluctuant area. The vaginal mucosa was normal and the vulvar skin showed no evidence of kraurosis, being healthy aside from the above described sinus and mild inflammatory changes. The cervix was small, of normal color and consistency, and showed no areas of erosion. The uterus was small, in normal position, and not tender. The adnexa were not palpable. Rectal mucosa was normal and movable, sphincter tone, good, with no bleeding. On deep palpation rectally a mass could be felt on the left anteriorly. It was quite hard, nodular, and very painful but did not involve the rectal wall. The inguinal nodes were enlarged bilaterally, quite tender and freely movable, but were soft rather than stony to palpation.

**Laboratory findings** Wassermann and Kahn tests were negative, hemoglobin, 75 per cent (Haden Hausser), white blood count, 11,600, urine, negative.

**Course in the hospital** A tentative diagnosis of malignancy with superimposed acute and chronic infection was made on admission. A biopsy was taken on June 16, 1937, and a diagnosis of squamous cell carcinoma of the vulva was made. From June 18 to June 26, 1937, she was given x-ray therapy to the tumor for the superimposed infection. This was given through anterior pubic, posterior sacral, and direct perineal fields. There were no burns and the skin was in good condition following this treatment. A total of 900 roentgen units was given, 200 through the anterior pubic, 100 through the posterior sacral, and 600 directly to the tumor. Treatment factors were 200 kilovolts, 15 milliamperes, 1 copper and 1 aluminum filter with a 50 centimeter skin test dose.

On July 3, 1937, under gas-oxygen-ether anesthesia a complete vulvectomy was done by Dr. Ralph Eddy. At operation there was a large indurated nodular mass deep in the left labium. It was approximately 6 by 8 centimeters in size. In the skin overlying the tumor there was a granulating wound, the result of incision made when the biopsy was taken. Posteriorly, near the opening of the duct, there was a small area 0.5 centimeter in diameter where the neoplasm had involved the skin. The tumor mass itself was found to extend from within 0.5 centimeter of the urethra anteriorly to the rectal sphincter posteriorly. Laterally it had involved the levator muscle on that side. The inguinal glands were not removed at operation.

**Pathologist's report** Case No 75-712. By Dr. Francis Woods, surgical pathologist. "The gross specimen consists of a mass of skin tissue composed of labia majora and minora which show a distinct brownish pigmentation."

"Under the skin on the left side is a large, firm mass buried deep in the fatty tissue. The mass measures approximately 5 centimeters in diameter. It is not encapsulated and on cut surface appears white and fibrous. A large sinus runs through the center of the mass and in many areas pus is easily expressed from it. Microscopic examination reveals many areas of fibrous tissue in which are scatterings of lymphoid cells (Fig 1). In other areas there is evidence of acute inflammation with infiltration of polymorphonuclear cells and areas of degeneration. Other areas show sheets of wildly growing squamous epithelial cells. In the center of most of these there is definite degeneration. Broken up cells and polymorphonuclears are seen in such areas and in the surrounding portions of these sheets of cells. Some of the nuclei appear to be shrunken and others to be fragmented. The degree of pigmentation of the

nuclei varies to a marked degree in these areas. A very few mitoses are seen (Fig. 2). In a number of areas in the fibrous tissue multinucleated giant cells are seen chiefly in areas where there is degeneration of tissue. There are no endothelial groups of cells to suggest tuberculosis. In some areas of the fibrous tissue the outlines of former acini can be made out but no normal gland tissue can be seen anywhere.

**Diagnosis.** Squamous cell carcinoma of Bartholin's gland. Sec No 777-881. The diagnosis of squamous cell carcinoma was confirmed by Dr. R. S. Austin, professor of pathology at the University of Cincinnati College of Medicine.

The patient was seen again October 3, 1937, 3 months after operation. At this time the wound was completely healed with no evidence of recurrence or metastasis. The inguinal lymph glands were not palpable.

The patient was again seen on March 3, 1938, 8 months after operation. The wound was in good condition, completely healed with no areas of tenderness or induration. There were no inguinal glands palpable and no evidence of local recurrence or metastasis could be elicited. X-ray examinations of the pelvis on October 13, 1937, and again on March 3, 1938, were negative.

#### REFERENCES

- BURGHELE W. N. Die malignen primitiven Tumoren der Vulva. *Zentralbl. f. Gynæk.* 1903 July Dec 1102.
- EDDY T. W. Quoted by Spencer. *Proc. Roy. Soc. Lond.* 1913-1914, 7, 101.
- FALLS F. H. Carcinoma of Bartholin's gland. *Am. J. Obst. & Gynec.* 1923, 6, 673.
- FRIEDRICH O. V. Ein Fall von Carcinom der Bartholinischen Drüse. *Monatsschr. f. Geburtsh. u. Gynæk.* 1904, 19, 60.
- GEIST. Inaugural dissertation. Würzburg, 1880.
- GODART. Carcinome de la glande de Bartholin. *Bull. Soc. belge de gynéc. et d'obst.* 1893, 9, 157.
- GRYNWELT E. and GONLEWSKI E. Primary epithelioma of Bartholin's gland. *Bull. de l'Ass. franc. p. l'étude du cancer. Par.* 1916, 25, 770-792.
- HARER W. B. Primary carcinoma of Bartholin's gland. *Am. J. Obst.* 1933, 25, 714-718.

- HOFFMAN F. E. Malignancies of the vulva. *Am. J. Obst. & Gynec.* 1937, 33, 60-67.
- HUNT C. V. and POWELL LESTER D. Mal disease of Bartholin's gland. *Surg. Clin. N. America* 1915, 6, 1325-1338.
- KELLY, HOWARD A. and NOBLE CHARLES P. *Gynecology and Abdominal Surgery*. P. 257. Philadelphia and London W. B. Saunders Co. 1907.
- LYLE H. H. M. Primary carcinoma of Bartholin's glands. *Tr. Am. Surg. Ass.* 1934, 52, 399-401. *Ann. Surg.* 1934, 100, 993-995.
- LYNCH F. W. and MAXWELL A. F. *Pelvic Neoplasms*. P. 32. New York and London D. Appleton & Company, 1922.
- MACHNEVRODT. Tumor bei bestehender Schwangerschaft. *Ztschr. f. Gynæk.* 1893, 26, 186.
- MARGARUCCI O. Primary carcinoma. clinical study. *Clin. obstet. Roma* 1937, 39, 265-284.
- MAYO C. W. and BARBER F. E. W. Carcinoma of Bartholin's gland. Report of 3 cases. *Surg. Clin. N. America* 1934, 14, 709-712.
- PAFF W. Carcinom der Bartholinischen Drüse von einer 91-jährigen Frau. *Deutsche med. Wchnschr.* 1907, 33, 1620.
- KABINOVIC J. Carcinoma of Bartholin's gland. *Am. J. Obst. & Gynec.* 1932, 23, 258-274.
- SCHÄFFER R. Ein Fall von altem Carcinom der Glandula Bartholin. *Ztschr. f. Geburtsh. u. Gynæk.* 1903, 50, 192.
- SCHWEIZER FRITZ. Carcinoma Glandulae Bartholin. *Arch. f. Gynæk.* 1893, 44, 322.
- SITZENTREY A. Horkrebs des Gangsystems der Bartholinischen Drüse zugleich ein Beitrag zur Genese der Protoplaste. *Ztschr. f. Geburtsh. u. Gynæk.* 1900, 58, 363.
- SPENCER H. R. Case of primary carcinoma of Bartholin's gland. *Proc. Roy. Soc. Med. Lond. Obst. & Gynec. Sect.* 1913-1914, 7, 102-112.
- STRAUSS HIRSH. Carcinoma of Bartholin's gland. Report of 2 cases. *J. Am. M. A.* 1933, 101, 2116.
- TATAGIC F. J. Etiologic study of vulvar carcinoma. *Am. J. Obst.* 1917, 76, 744.
- TROTTER. Un Caso di Carcinoma della glandola del Bartholini. *Arch. di obstet. e ginec.* 1900, 7, 193.

# PARASAGITTAL MENINGIOMAS: OPERATIVE TECHNIQUE SUGGESTED FOR EXPOSURE

JAMES L. POPPEN, M.D., Boston, Massachusetts

THE exposure of a large parasagittal meningioma may be the most difficult part of the operation in attempting its removal. Several helpful methods have been employed in the past few years which have facilitated the work on the bone and at the same time have given adequate exposure for the removal of the tumor.

Large bony defects resulted after operation in many of the cases of parasagittal meningiomas such defects depending, of course, on the extent of the bony involvement as well as on whether the tumor involved the sagittal sinus. It was felt that the better part of valor was to rongeur bone away as the exposure was needed. This increased both the operating time as well as the loss of blood, since each bite with the rongeurs opened up large vascular spaces.

The following 3 methods of attack may be used, depending on the conditions found at the time the procedure is carried out. With this technique, a satisfactory exposure may be made avoiding the sanguineous struggle which may ensue if an attempt is made to go through part of the vascular bony enostosis which is frequently present.

From the Department of Neurosurgery, The Lahey Clinic

## OPERATIVE PROCEDURE

Since it is difficult to be certain before operation that the tumor does not extend across the midline, the medial portion of the scalp incision is made well beyond the midline. The scalp and periosteum are reflected as far as is necessary so that the extent of the bony involvement, as determined by a definite area of increased vascularity, may be determined. The course of the sagittal sinus may also be readily noted by the external appearance of the bone. The burr openings are then made as shown in Figure 1, the only change from the ordinary bone flap being that the medial portion of the bone flap is well past the midline, allowing excellent exposure of the tumor even if it should extend across the sinus. Emphasis is placed on the fact that a burr opening should be made immediately to either side of the sinus in both the anterior and posterior limbs of the bone flap, so that they may be readily connected with a Montevesi bone cutting instrument, thus avoiding possible injury to the sinus with the Gigli saw. The remaining burr openings are connected with a Gigli saw, starting the saw cut with the conventional bevel and continuing in this manner for two-thirds of the distance and then abruptly

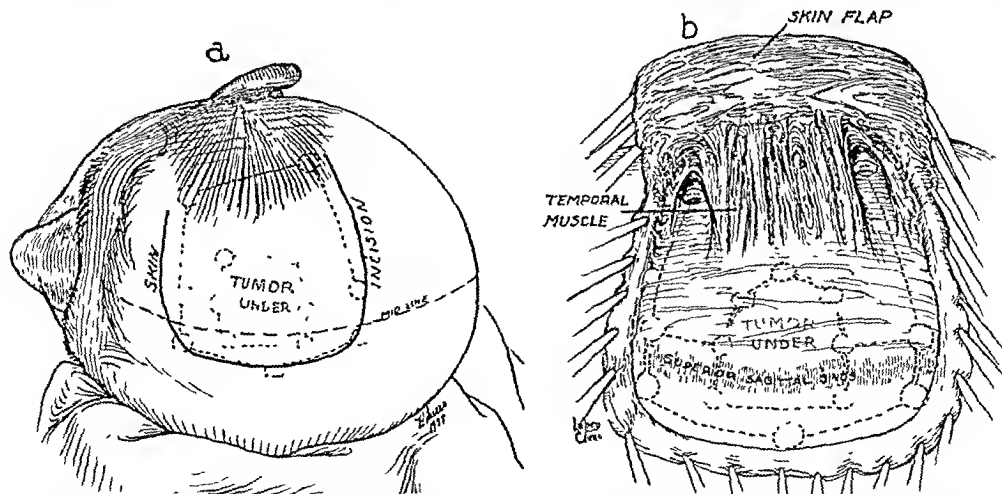


Fig 1 a, Outline of scalp incision well beyond midline and site of tumor b, Scalp flap with periosteum reflected to allow burr openings to be made around involved bone overlying tumor Also the relationship of burr openings to the sagittal sinus is illustrated

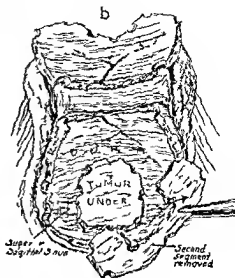
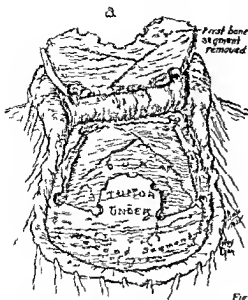


Fig. 1

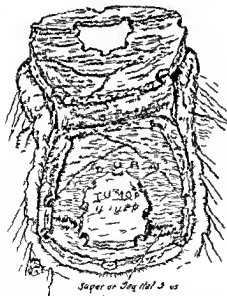


Fig. 3

Fig. 2. The bone flap elevated as a whole. Note bevel of saw cut. The bone flap is turned down in this manner only when the dura is not adherent and roentgenograms demonstrate minor bony attachment to tumor.

Fig. 3. Entire bone flap raised with exception of the cutting the rest of the bone at an acute angle. If the latter is done with each cross cut it creates a slot effect making it impossible for the bone flap to slide out of position after it is once in place.

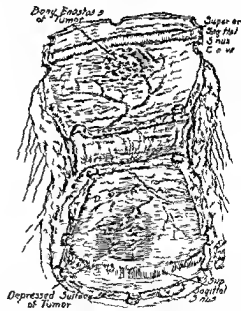


Fig. 4

bony attachment to tumor. Note window in bone flap.

Fig. 4. a Bone flap with sinus and tumor turned down bone over tumor and #2 still intact. b The bone segments removed in 2 pieces. The 2 steps are used when the dura is adherent to the inner plate throughout.

During the process of passing the sinus from one bone opening to the other the surgeon has become acquainted to some extent with the degree of adherence of the dura to the inner plate of the

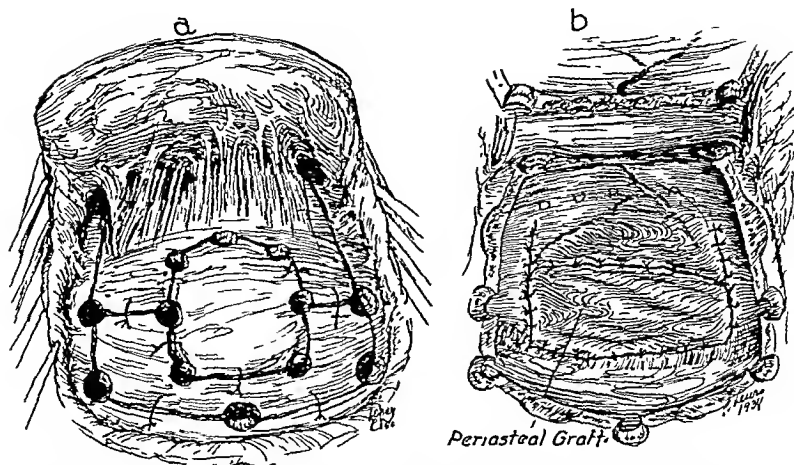


Fig 5 a, Dural defect filled in with a periosteal graft removed from inner surface of scalp flap after tumor has been removed b, Bone segment replaced and kept anchored with a few black silk sutures taken through tiny burr openings through the edges of the bone

calvarium with exception, of course, of the bony enostosis. Also much will have been learned about the degree of vascularity. If it has been noted that the dura is readily separated from the inner plate and previous roentgenograms have given evidence of only a mild enostosis overlying the tumor, the entire bone flap (Fig 2) may be safely elevated if the staphylorrhaphy has been used to free the sagittal sinus through 2 or 3 burr openings made along one side of the sinus. It is always wise of course to have muscle at hand which has been collected from previous general surgical patients operated on that same day.

If a rather large or deep enostosis has been demonstrated roentgenologically, it is likely to be firmly adherent to the tumor making it unwise to elevate the entire bone flap as a whole. Therefore, provided that the dura is not adherent elsewhere, many burr openings are made encircling the well demarcated vascular area in the bone. These burr openings are readily connected with a bone cutting forceps. This allows the bony attachment to the tumor to remain *in situ* as the rest of the bone flap is elevated (Fig 3). The fragment of bone then may be left in place while the tumor is removed or may be carefully separated from the surface of the tumor with a periosteal elevator before the dura is opened.

If the dura has been found to be firmly adherent throughout, as evidenced by difficulty in the guides for the Gigli saw through the burr opening, the technique in Figure 4 should be followed. The bone flap is elevated in 3 segments. The portion corresponding more or less to the ordinary

type of bone flap is turned down with the segments covering the tumor and sinus left attached. These may be gently freed with a periosteal elevator, with care to avoid tears in the dural sinus.

After the intracranial tumor has been removed by the Cushing technique, which is well known, the resulting defect in the dura may be readily repaired by removing a strip of periosteum (Fig 5, a) from the inner surface of the scalp flap. The fragments of bone are replaced after the portion overlying the tumor has been boiled or a corresponding segment removed from the inner plate of the bone flap to replace the portion involved with the tumor, the latter may then be discarded. These bone segments may be anchored with a few black silk sutures as shown in Figure 5, b.

The above procedures allow adequate exposure of the tumor even if a portion of the sinus has to be resected due to invasion of the tumor. Also, any tumor can be taken care of that may have crossed the midline. A minimal amount of defect is left since bone dust may be saved from the burr openings which are well away from the tumor and be used to fill in the openings at the time of closure.

#### SUMMARY

- 1 Parasagittal meningiomas may be difficult to remove especially if enostosis is present.
- 2 Three methods that may be followed are given. Decision as to which to follow can be made only at the time of craniotomy.
- 3 The general principles may be followed in any convexity meningioma that has an adherent bony stalk.



# EDITORIALS

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MAY 1939

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## NEPHROPEXY

IT is quite generally understood by physicians that stone in the upper urinary tract may cause symptoms and exhibit all the signs of acute lesions of the abdominal organs particularly those of the appendix and gall bladder. Twenty five years ago and more rarely during recent years, it was not an uncommon occurrence mistakenly to remove the appendix or explore the gall bladder in cases of urinary calculi. Numerous reports of cases and discussions of this question have convinced the present generation of surgeons of the need for a roentgenogram and an examination of the urine before resorting to an abdominal exploration. If no evidence of urinary tract disorders is found the abdomen is opened and at least the appendix is removed with a certain feeling both of finality and of security.

What is not so generally recognized is that a low lying shifting kidney can simulate most of the lesions occurring in the right side or more rarely the left side of the abdomen. It

is not necessary to have a Dietl's crisis to implicate the kidney. Evidence of ureteral obstruction or pelvic dilatation may not be demonstrable. Tension due to the traction of a dislocated but otherwise comparatively normal kidney may obstruct the bile ducts or constrict the duodenum, initiating a chain of symptoms which may be indistinguishable clinically from primary disease of these organs. Such cases, while rare have not been found to be unusual.

In the period between 1900 and 1910 nephropexy next to appendectomy was the procedure of choice for pain in the right side of the abdomen. It was a simple clean cut procedure which was easily performed with a low mortality even by operators of little training. Many developed their own methods of suspension and medical periodicals contained numerous descriptions of bizarre and spectacular procedures, the very number and variety of which suggested neither satisfactory nor uniformly good results. In fact unfavorable results were frequently seen. In some cases the nephropexy was done when not indicated, in others the suspension was poorly executed and did not hold the kidney in a sufficiently high position. Occasionally improper fixation permitted the kidney to pull loose, carrying other structures with it in its trip downward, thus causing further disability. In rare carefully selected cases, excellent cures were obtained but the few favorable outcomes were overshadowed by numerous unfortunate results.

Such unfavorable results were bound to cause a reaction, and from 1910 to 1920 almost no reports of cases appeared in the literature. From 1917 to 1924, in 7 years of observing

surgery at several of the larger surgical centers, I saw only four nephropexies performed, and these were done hurriedly, with a great deal of reluctance as well as with many apologies

The operation had been discredited, and in the minds of many of the older surgeons, it is still a procedure to be performed only as a last resort. More recently, reports of cases of patients successfully operated upon are again beginning to appear in the literature, usually qualified by a discussion of the limitations of the procedure and the desirability of properly selected cases. Many of these articles are by leading urological surgeons, and the success they have met with in treating these patients must be considered in our handling of similar cases.

Partially due to the early bad repute of this procedure, nephropexy is still rarely considered as the initial procedure. All other measures are exhausted before renal suspension is considered. In a recent review of cases of nephropexy, all done on the right kidney, 57 per cent had some previous abdominal operation for the relief of right-sided abdominal pain. Almost one-third of those who had been operated upon previously had two, three, four, or more operations. In all cases but one, nephropexy was the last operation, and all but two patients were relieved of their pain by the operation.

I am not entering a plea for widespread adoption of the operation of nephropexy, but I do offer the suggestion that the low-lying, movable kidney which is so frequently symptomless may also be the primary cause of the patient's disability. It is my belief that there is a small group of patients in whom urological investigation might save needless surgery and also that nephropexy is the only procedure that will give these patients relief.

A. J. SCHOLL

## THE IMMEDIATE TREATMENT OF COMPOUND INJURIES

MANY a medical student and hospital interne has dreamed of the day when his big moment would come—when the opportunity to demonstrate his ability would suddenly, and perhaps dramatically present itself; and he has told himself again and again just what he would do under such circumstances. Today one can promise him with assurance that the opportunity will probably come very early in his career—in the form of a badly lacerated forehead or face, a hand or forearm with division of nerves and tendons, an extensive avulsion of skin and soft tissues from upper or lower extremity, a compound fracture of both bones of the leg. The summons will probably come in the dark of the night or in the early hours of the morning. He will not be asked to present his credentials of membership in the College of Surgeons or any other organization, a plain "M D" will suffice. There will be no question of calling older and wiser colleagues into consultation; or of referring the patient to some one with more experience. He will only be implored to hurry, and asked for the assurance that life will be saved and that there will not be hideous and deforming scars as a result of the injury.

Will he accept the chance and "field the ball" perfectly? Much depends upon his understanding of two golden principles of good surgery—patience and gentleness. Patience, because the transformation of a lacerated badly contaminated wound into a clean surgical wound, susceptible of immediate repair, is no task for the impetuous and irritable surgeon whose motto is "Speed." Gentleness, because living tissues are delicate fragile structures that respond in remarkable fashion to gentle handling, but that can be destroyed by

chemical and mechanical trauma as easily as the petals of a fragile flower. If patients always came to the surgeon in the form of a Greek god or goddess it might be easier to visualize living tissue as a delicate, wonderfully fragile and strangely beautiful structure. To realize that the blood stained, crushed and distorted mass of flesh and bone which often confronts the surgeon after a serious injury can be restored into a useful and symmetrical face or hand or leg requires imagination, and a certain genius for patience and gentle care.

More specifically, an increasing experience has fortified us in the opinion that for the patient with a compound injury the most satisfactory first aid dressing is the simple application of a sterile dressing and a pressure bandage to stop oozing of blood, and *nothing more*. Why? Because forceps not completely sterilized, catgut ligatures applied in haste in an emergency room, interested bystanders with uncovered mouths and noses talking excitedly over an open wound—these possible sources of infection we have come to fear more than the knife or the glass or the metal that caused the wound.

At the earliest possible moment and under suitable conditions the area about the wound should be carefully cleansed with plain white soap, which is less irritating than green soap or tincture of green soap and with soft sterile cotton, held in hands covered with sterile gloves. When the area about the wound is cleansed the wound itself is gently, patiently, and thoroughly cleansed in the same fashion, and thoroughly irrigated with warm saline solution. If the wound is clean cut, the result of a knife wound or glass cut and looks perfectly clean to the naked eye, the soap and water cleansing of the wound itself can be omitted, and the irrigation with warm saline carried out as soon as the cleansing of the area about the wound is complete. A blood pres-

sure band to secure hemostasis in an extremity, sterile retractors to expose the depth of the wound during the process of irrigation, careful masking of everyone in the room—are all important details that help to secure the desired result.

When cleansing of the wound is complete, if the surgeon is satisfied that he has converted the contaminated wound into a clean wound, repair is in order. This includes the careful preservation of tissues whose blood supply is intact, reduction of fractured bones or fractured tendons and nerves, complete hemostasis, accurate wound closure, a large dressing so as to apply uniform and elastic pressure over the wound area, a splint to immobilize the injured tissues and favor healing.

If one is doubtful as to the completeness of the cleansing process or if the "safe interval" has passed, the repair of structures that involves dissection and further exposure of tissues should be omitted. The same careful cleansing, the same reduction of fractured bones should be carried out, the covering tissues can be left open or loosely sutured—as judgment and experience indicate. Our own practice tends more and more toward wound closure if hemostasis is satisfactory and the injury has not been of the crushing type.

After operation the carefully immobilized part is left alone for 3, 4, 6 days unless some definite indication arises for disturbing the dressings. If a patient is comfortable afebrile, resting well at night one can wisely restrain his curiosity to see what is going on underneath the dressings. The patient should be watched with the greatest care, the wound is best left alone until the sutures should be removed.

The question of shock, the necessity for transfusion, the careful pre-operative examination of the patient, not the wound to determine the extent of injury are important con-

siderations that cannot be discussed here. The actual care of the compound injury—from the moment the patient comes to the doctor—is the responsibility of the man who first sees the patient. If his treatment is wise, painstaking, well considered often nothing more than time and simple after-care is

needed to restore the patient to health and normal activity. If not, it too often happens that nothing in the way of skillful surgery or prolonged treatment can compensate for haphazard or unthinking care immediately after the injury has been sustained.

SUMNER L. KOCH

# ACROSS THE EDITORIAL DESK

IT SEEMS too bad that custom habit, and the laying down of certain rules of form and order have all combined to discourage the development of an individual style of writing by medical authors. There is unquestionably one writer on purely scientific material who is a stylist and he succeeds in making his articles living interesting stories of his experimental and clinical investigations. That author is, of course, Dr Harvey Cushing. Since most of us are wholly unable to approach Dr Cushing's accomplishments in the field of medical writing perhaps it would be better if we wrote simply, directly, briefly, and to the point. Tradition and custom have required the use of extensive historical reviews and citations of literature which in many instances are not pertinent, simply because the author is fearful that his readers will not recognize that he has made a careful and complete study of the subject about which he is writing.

A GOOD example of what is meant by concise brief statement of a problem and the points to be emphasized is BLACKFIELD'S paper on burn contractures of the hand which will be published in the near future. Blackfield's important points that contractures may be prevented by early and proper skin grafting and his clear description of the essential technique of the types of grafts to be used in early and late cases and the principles covering the use of grafts are not hidden by unnecessary verbiage.

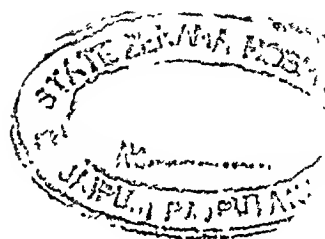
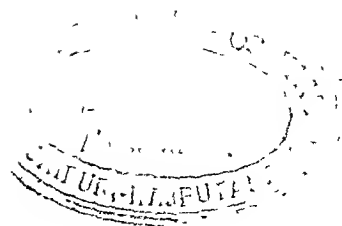
WE FEEL sure that all of our readers will be interested in three papers which make up a very careful study of 70 patients with cancer of the cervix who have been treated at the Pondville Hospital. This is the Cancer Hospital of the Massachusetts Department of Public Health. Seventy cases of cancer of the cervix treated by x-ray and radium have now been traced for 5 years and longer and the results are given by Dr MEXES and his associates. In another paper the extreme importance of the genito-urinary system in cancer of the cervix is emphasized, and another interesting fact resulting from a study of these cases is the authors' belief that one may be able to choose cases for surgery because of the patients' reaction to radiation rather than simply because they are early cases.

Besides being well written these papers are excellent examples of careful detailed study of a group of cases which offer more than a statistical study of percentages.

ARTICLES by WERNICKE and BECKMAN and SULLIVAN deal with that perennial problem of the treatment of hernias. Wernicke's paper is a good, clear, and fair statement of the value of the injection treatment of hernia and seems appropriate at this time when enough material should be available upon which to base a judicial statement as to its value. Everyone recognized from the beginning that it was not a simple and foolproof method and that it was not without danger even in experienced hands. That the injection treatment has merit in certain cases is true, even though the ideal solution for injection has not yet been developed. Wernicke, however, believes that the method cannot supplant surgery in the majority of instances and he warns against the indiscriminate use of solutions by those unskilled in the technique.

In connection with this paper the analysis of Beckman and Sullivan of the immediate post-operative complications in 2000 cases of inguinal hernia in relation to infections, anesthesia, suture material used, and other factors is particularly worthy of attention. The pendulum swings a long way in both directions in surgical therapy. Sometimes it is difficult to wait until it has settled down to its midposition.

IT IS unfortunate that the cost of reproducing colored illustrations is so great to the author and to us because an article on the study of 200 specimens of human endometrium is accompanied by colored illustrations which would lend themselves particularly well to reproduction, but Dr CLEVELAND of Vanderbilt University has decided and we agree after our initial disappointment that black and white reproductions of his illustrations showing the study of nuclei and the chromatin distribution in these specimens of endometrium will accurately reproduce his findings. Cleveland's observations suggest that the difference in the threshold response of the gland and stromal nuclei of the human endometrium to hormonal stimulation may furnish a basis for determining fluctuations in endocrine levels.





JOSEPH C BLOODGOOD  
1867-1915

# MASTER SURGEONS OF AMERICA

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## JOSEPH C. BLOODGOOD

**O**N October 22, 1935, the medical profession, and particularly that part dealing with surgical diagnosis, lost one of its most dynamic members. Born in 1867 on the first of November in Milwaukee, Wisconsin, Dr Bloodgood began his professional career by graduating from the University of Wisconsin in 1888 and receiving his medical degree at the University of Pennsylvania in 1891. His whole professional life was spent in connection with Johns Hopkins Medical School and Hospital, where he was assistant resident surgeon, later resident, assistant instructor, associate, and finally associate professor of clinical surgery.

As a young prospective surgeon his environment was filled with the enthusiasm of his master, W. S. Halsted, one of the pioneers of modern surgery. Dr Halsted approached his own progress from two angles, animal experimentation and surgical morbid anatomy. It was the latter approach which apparently appealed to Dr Bloodgood. He became the instructor of surgical pathology which continued to be his field throughout his life. He was probably the first physician in the United States to devote the major part of his time to surgical morbid anatomy and who was to gain recognition as a great surgical pathologist. A review of his published articles, as well as of his many demonstrations for his colleagues and the profession, shows clearly that surgical pathology and surgical diagnosis were his main interests. Quite naturally these interests dealt largely with all forms of malignant tumors, he became known, therefore, as an authority on cancer and he spent the last years of his life publicly and professionally enlightening all upon this destructive disease—its nature, diagnosis, and treatment.

In the last part of the nineteenth century William Ostwald, distinguished chemist and philosopher, divided men into two main groups—*die Klassiker* and *die Romantiker*. He described the first as being rather slow at observation, correlation, generalization, and utilization, not unusual in childhood, producing rather slowly, and not as a rule great teachers. The second group was composed of those rapid in their reaction time, they produced work in large quantity, and rapidly. This group contained the enthusiastic teachers. If this be a correct division of men, then I feel that Dr Bloodgood must have belonged to the second or romantic group. Certainly he did great quantities of work and this very rapidly. Certainly he inspired a great following. He was not a creator of new ideas nor a discoverer of new facts, but he was an extremely valuable teacher of selected facts he quickly saw in his abundant material and deemed valuable for



his profession and his fellow countrymen. He took an active part in all movements leading to the diffusion of knowledge of cancer. No member of the profession had closer contact with, and a greater influence over, the lay press than did Dr Bloodgood. This, his tremendous enthusiasm led him to use for popular education which is neglected too frequently by our profession.

I, personally, feel no one will take his place in the many medical meetings where one almost always was certain to hear him bring his enthusiastic plans for early diagnosis of cancer. His great personality as well as his carefully studied statistical facts relative to prognosis in neoplastic diseases will be missed not only by specialists in his field but by the average general practitioner throughout the country. They knew him personally, believed in his diagnostic ability, and had the greatest respect for his abundant and concentrated professional experience which lasted well over forty busy and useful years.

WILLIAM CARPENTER MACCARTY

# THE SURGEON'S LIBRARY

## REVIEWS OF NEW BOOKS

THE new, seventh edition, of Kanavel's *Infections of the Hand*,<sup>1</sup> completed just before the author's death, carries on the tradition of previous editions of this authoritative work. The arrangement follows the same splendid plan as in the previous edition. There is first a consideration of the anatomy of the hand and forearm, especially as related to infections and their spread as determined by anatomical dissections, by cross sections, by injection experiments, and by clinical observations. The outlines of the principal fascial spaces are described and illustrated in relation to surface and deep landmarks, together with their relations to one another, to the flexor tendon sheaths, to the lumbrical canals, and to the major forearm space. This complex subject is so handled that it can be readily comprehended by the attentive reader. This is followed by a brief description of the superficial and deep lymphatics. The importance of placing the infected hand in the "position of function" throughout the course of treatment is emphasized by devoting one entire, though short, chapter to this important topic which is referred to again and again throughout the book. It is described as the position in which "maximum power can be exerted with least effort" and in which "many important motions can be carried out with a minimum of motion."

The general principles of treatment are next considered, some of the more important being the following. Incisions in a bloodless field under general anesthesia to allow adequate opening, accurate dissection and avoidance of vessels and nerves, incisions sufficiently large so that drains can be reduced to a minimum, immobilization of the hand in the position of function in a massive wet dressing, the use of passive hyperemia for 18 to 24 hours following incision, removal of all drains after 24 to 48 hours, the making of all dressings under strict aseptic precautions, the time for discontinuance of wet dressings, the use of arm baths from 20 to 30 minutes each day, followed by dehydration by dry heat, then a light dry dressing, and physical therapy to restore function at the earliest possible moment.

A very valuable chapter is the one on prophylactic treatment of injuries, emphasizing as it does gentle cleansing of the injured parts with soap and water with no strong antiseptics in the open wound, and débridement of devitalized tissues followed by immobilization in the position of function.

The diagnosis and treatment of specific infections are next discussed first, felon, paronychia, carbuncle,

mycotic and other superficial infections, next, abscesses in the minor spaces, then infections about the metacarpophalangeal joint which are due chiefly to a tooth penetrating the skin over the knuckle in a fist fight. This is followed by a consideration of gangrenous infections, streptococcal, symbiotic, and gas bacillus.

Part III contains separate chapters on the diagnosis and treatment of lymphangitis and infections of the separate tendon sheaths, and of the major fascial spaces, together with a description of possible extensions from a given point of infection, and specific direction as to how to incise each sheath and each of the fascial spaces. Slight modifications in the incisions recommended in previous editions for drainage of the thenar and middle palmar spaces are described.

The final division of the book, Part IV, is concerned with the complications and sequelae of infections of the hand, such as osteomyelitis, hemorrhage, ankylosis, and contracture, discussing their prevention, diagnosis, and treatment. The last few chapters describe methods and apparatus for physical therapy and the types of basic but easily made splints to be used during treatment.

The book is well printed on excellent paper, is profusely illustrated and each chapter is ended by a résumé of the entire chapter, which is a considerable help to the reader and should be of value to students.

MONT R. REID

IF the reviewer believes his task in reviewing such a voluminous work as Meakins' *The Practice of Medicine*,<sup>2</sup> is somewhat arduous, he may console himself with the thought that it is infinitely more laborious to write such a book. This book is the product of Dr. Meakins' own effort. A few sections have been written by his associates but under the critical supervision of the author. It has been said that the present status of medicine has made it impossible that a satisfactory textbook of medicine be written by a single author. Dr. Meakins has upset this statement. Indeed, his book may be cited to show that in many respects single authorship is superior to any other.

The book consists of twenty-one chapters in which the non-surgical maladies of the body are discussed. Included in this discussion are short sections on diseases of the nervous system and of the locomotor system. The author has jettisoned the usual stereotyped approach to and consideration of individual diseases. He adopts the much more logical method

<sup>1</sup>INFECTIONS OF THE HAND, A GUIDE TO THE SURGICAL TREATMENT OF ACUTE AND CHRONIC SUPPURATIVE PROCESSES IN THE FINGERS, HAND AND FOREARM. By Allen B. Kanavel, M.D., Sc.D. 7th rev. ed. Philadelphia: Lea & Febiger, 1939.

<sup>2</sup>THE PRACTICE OF MEDICINE. By Jonathan Campbell Meakins, M.D., LL.D. 2d ed. St. Louis, Mo. The C. V. Mosby Co., 1938.

of setting forth a general description of the symptoms produced by disorders of the portion of the body under discussion. For instance the discussion of diseases of the stomach is prefaced by a general consideration of appetite, anorexia, pain, nausea, and so on. Later these symptoms are fitted into the pictures of ulcer, carcinoma, syphilis, and so on. This method of approach is used throughout the book wherever possible. It makes a much more readable book and saves much of repetition. It is difficult to single out any one portion of the book for special commendation. Diseases of the hematopoietic system with excellent plates is especially good. The discussion of cardiac arrhythmias is very clear and concise. The approach to the subject of heart failure is very well done.

In any work of this sort in which the author must crowd a vast amount of information into a relatively small space, the problem of selection of material becomes paramount. The author must decide what to omit, not what to include. Whatever sins there are in this book would seem to be sins of omission. A few examples follow. In the treatment of neglected diphtheria no mention is made of the inestimable value of large amounts of intravenous glucose. The efficacy of vein ligation as a prophylactic against pulmonary infarction complicating thrombophlebitis is not brought out. The value of muscle biopsy in the diagnosis of Buerger's disease seems to have escaped notice. The work of Beck and O'Shaunnessy in the treatment of coronary artery disease has apparently not impressed the author. There is no mention of the erythrocyte sedimentation rate as an aid to the diagnosis of coronary occlusion. The brilliant results of pericardiectomy for compressive pericarditis are dismissed with a single line. The administration of dilute hydrochloric acid to patients with pernicious anemia still gives symptomatic relief.

There will also crop up certain differences of opinion in the matter of treatment. It is doubtful that the treatment of pulmonary tuberculosis may be adequately presented in three scant pages. The treatment of aortic aneurysm carries an optimistic note that may bring disappointment. There is certainly no unanimity of opinion that coronary dilators are of little value after the coronary infarction has occurred.

There are some startling innovations in the classification of disease. Lobar pneumonia and typhoid are no longer acute infectious diseases. They are respectively diseases of the respiratory and gastrointestinal tract. It would seem equally logical to treat erysipelas as a disease of the skin. It is difficult to see why agranulocytic angina is a disease of the hematopoietic system while acute mononucleosis is an acute infectious disease.

These minor criticisms should not be allowed to militate against the general excellence of the book. It is obvious that perfection is unattainable, but Dr. Meakins has come as close to it as any one perhaps a wee bit closer. The student and the practitioner will find this book filled with essential in-

formation presented in a delightful fashion and well worth careful perusal.

G. K. FENN

A MONOGRAPH by an experienced anesthetist written for anesthetists is Maxson's *Spinal Anesthesia*.<sup>1</sup> It contains a thorough discussion of the problems which confront one in spinal anesthesia. Simple black and white diagrams elucidate the anatomical and physiological considerations pertinent to this method. The various drugs used for the technical variations, the failures, difficulties, dangers and mortality, the complications and late sequelae, advantages and disadvantages, indications and contra-indications, and finally special techniques are given due consideration.

The use of hypobaric instead of hypotonic solutions sounds a little unfamiliar. The bradycardia observed in high spinal anesthesia is attributed to a partial block of the cardiac accelerator fibers, which is not confirmed by experience with the paravertebral block of the upper dorsal sympathetic ganglia. A more likely explanation is a central vagal stimulation caused by the fall in systemic blood pressure. While the author emphasizes the importance of maintaining blood pressure during anesthesia, he does not seem to stress the harmful effect on cerebral and coronary circulation of even temporary and moderate dips of the pre-anesthetic level. Not only the novice as the author recommends, but the experienced anesthetist can benefit by blood pressure determinations as they frequently precede the clinical signs and symptoms of acute hypotension.

The author modestly refrains from recommending a definite type of technique and quotes verbatim many authorities; this may be an advantage to experienced anesthetists. It must be remembered, however, that thousands of general surgeons throughout the country are in need of a simple, safe and generally applicable technique. It is to be hoped that in a future edition the author will recognize this existing need. Even if large institutions will continue to build up efficient departments of anesthesia, surgeons in smaller communities will have to be doing their own spinal anesthesia, with a control of blood pressure by a nurse. The method has its place in surgical practice.

CRAIG DE TAPATS

THERE has been a complete revision of the text of *Urology*<sup>2</sup> since the last edition a years ago. The book retains the former divisions of chapters according to the individual components of the urinary tract as applied to both sexes and those of the male genital tract. The chapter on gonorrhea in the female has been revised by Irving F. Stein.

The new edition is profusely illustrated and contains some excellent new views of genital lesions. In this connection there is included an outline of treatment of early syphilis as adopted by the Co-Opera-

<sup>1</sup>SPINAL ANESTHESIA. By LOUIS H. MAXSON, A.B., M.D. Foreword by W. WAYN HANCOCK, M.D., LL.D., F.A.C.S., Philadelphia. Lo, D. N. Y. & Co. Inc. 1931. J. B. Lippincott Co. 1935.

<sup>2</sup>UROLOGY. By J. D. STEIN and N. L. LIPPINCOTT, M.D., and H. C. HARRY C. ROBINSON, M.D. 4th ed. Philadelphia. J. B. Lippincott Co. 1935.

tive Clinical Group of the United States Public Health Service. This revision embraces the newer studies of the male sex hormones and the gonadotropic principle found in the urine as applied to diagnosis and treatment.

There is an excellent chapter by Maurice Muschat on neurogenic dysfunction of the bladder. The space devoted to non-tuberculous and tuberculous infections, nephrolithiasis and renal tumors, includes the recent changes in the concepts of their etiology, diagnosis, and treatment. The medical aspect of nephritis receives its just place in the urologic textbook. Special chapters are devoted to urology in the female and in children.

It is gratifying to note that the sections on gonorrhea have been condensed into two chapters. In the former editions, as well as in most urologic texts, the large amount of space devoted to this subject is confusing to the student. The authors have long been noted as authorities on anomalies, and on the genital tract, so naturally the sections are monographs on these subjects. The two chapters on sterility in the male and the sex neuroses are handled in a direct and simple manner without the usual confusion. The short section on anesthesia is admirably managed and complete, although surprisingly brief.

An inspiring innovation in the introduction of a page before each section, entitled "Orientation," in which the student and practitioner are briefly acquainted with the subject matter and purpose of that section. Each chapter is headed by a short list of its contents and relative position in the text. The table of contents is in great detail and the index is complete. This edition omits the use of heavy type for emphasis, which adds greatly to the appearance of the page.

Eisendrath and Rolnick's book is the best of its kind for the student and practitioner.

L. L. VESEEN

EVERY medical student and physician is well aware of the fact that neurophysiology is a complex subject. One reason for this is that very few comprehensive and well organized treatments of the subjects have been available, and none have been available which contain the important recent advances in this field. Most reviews and discussions of the subject include such a wealth of uncorrelated detail and the presumption of an intimate knowledge of the subject that the average reader is unable to see the forest because of the trees. Fulton in *The Physiology of the Central Nervous System*<sup>1</sup> has very successfully correlated the details of neurophysiology in an intelligible and logical manner. The book begins with the sensory receptor organs and nerves, proceeds to a discussion of the intimate behavior of the reflex arc and its component parts, then takes up the activities of the spinal cord, medulla, pons, mesencephalon, the autonomic system, the hypo-

thalamus, thalamus, the various functional areas and systems of the cerebrum, and concludes with an exposition of the functions of the cerebellum.

Each chapter begins with an informative historical note and concludes with an excellent and most helpful summary. The liberal use of subheadings, italics, and illustrations are of considerable aid to the reader. Where necessary, sections or whole chapters are devoted to anatomical description. The book is invaluable if for no other reason than that its complete and accurate bibliography contains 1361 titles.

The book is thoroughly up-to-date for it covers the literature up to within several months of its own date of publication. The reader cannot fail to be impressed with the rapid advances that have been made in recent years in this field, for the greater proportion of the text is concerned with material reported within the past eight years.

Throughout the text the comparative viewpoint is emphasized. Where species differences occur, they are clearly indicated and their significance is pointed out. In this way the differences instead of being confusing are illuminating, for they reveal the gradual transition from lower forms to man. In this connection the more recent findings in the higher primates are carefully considered, since they provide the important link between the lower mammals and man.

The outstanding characteristic of this book, and one which will earn it many grateful readers, is its splendid organization. Although one might take exception to some of the views expressed by the author, the fact that a high degree of order has been introduced is sufficient reason to render the book very valuable to anyone who desires to know more about the physiology of the nervous system.

A. C. IVY

CABOT'S *Physical Diagnosis*<sup>2</sup> needs no introduction to the medical profession. The first edition offered in 1900 and now entirely re-edited in its twelfth edition is indeed worthy of the part it has taken as an outstanding reference book for the practitioner of medicine and especially as a textbook for the medical student in the correlation of physical findings and organic disease. Dr. Adams has collaborated with the author in the composition of this edition and now the book in its twelfth edition bears the double authorship.

Some three hundred more pages of material has been added over the eleventh edition, although the opening chapters are similar, with emphasis on the importance, method and plan of history taking, followed by general consideration of the patient as a whole. Then regional examinations are taken in order, with clear and complete discussion of the technique of percussion and auscultation greatly amplified with numerous illustrations. Following are separate chapters devoted to rheumatic heart dis-

<sup>1</sup>PHYSIOLOGY OF THE CENTRAL NERVOUS SYSTEM. By J. F. FULTON, M. A., B. Sc. (Oxon), S. B., M. D. London, New York, and Toronto: Oxford University Press, 1938.

<sup>2</sup>PHYSICAL DIAGNOSIS. By Richard C. Cabot, M. D., and F. Dennette Adams, M. D. 12th ed. Baltimore: William Wood & Co., 1933.

ease cardiac decompensation, systemic hypertension and coronary disease. Throughout the chapters on pulmonary disease, and the abdomen the same plan of presentation is continued with correlation of the findings and underlying pathology. The chapter on Examination and Diseases of the Joints has been greatly enlarged with diagrams of the normal joint movements and their degrees of rotation flexion or extension. The final chapter has been devoted

to the nervous system and is much more detailed than in earlier editions illustrating with pictures the method of obtaining reflexes and ending with the disease entities and the pathological findings.

Throughout the entire twelve editions no one edition has been rewritten with more benefit to the reader and it will undoubtedly continue in its established place as an outstanding modern conception of this subject.

EDMUND A. GORVETT

## BOOKS RECEIVED

OUR SEX LIFE. A GUIDE AND COUNSELLOR FOR EVERY ONE. By Fritz Kahn, M.D. Translated from the German by George Rosen, M.D. New York, Alfred A. Knopf, 1939. L'OBSTÉTRIQUE À TRAVERS LES ÂGES. By L. Desvignes. Paris, G. Doin & Cie, 1939.

THE VAGINAL DIAPHRAGM: ITS FITTING AND USE IN CONTRACEPTIVE TECHNIQUE. By Le Mon Clark, M.S. M.D. St. Louis, The C. V. Mosby Co., 1939.

GONORRHEA IN THE MALE AND FEMALE: A BOOK FOR PRACTITIONERS. By P. S. Pelouse, M.D. 3d rev. ed. Philadelphia and London, W. B. Saunders Co., 1939.

STERILE ANATOMY. By W. E. Roberts, M.R.C.S. L.R.C.P. Foreword by A. N. Bullett, M.B. B.Sc. Sydney, Australia, Angus & Robertson Ltd., 1937.

PLAN IVS AC. JERUSALE CIVILIS (Outline of Obstetric and Gynecology). By Prof. P. A. Kashenski. Kiev, Dershavne Medicine Vidavnetstvo, 1938.

SOUDERBARDE ZUR STRAFRECHT. Edited by Prof. Dr. Har. Meyer. Vol. 13—DR. BEKAENFTUNG DES GEB. ERBUTTERKREISER. By Dr. Hans Reichenmiller. Berlin and Vienna, Urban & Schwarzenberg, 1939.

GROSS ANATOMY: A BRIEF SYSTEMATIC PRESENTATION OF THE MACROSCOPIC STRUCTURE OF THE HUMAN BODY. By A. Brazer Howell. New York and London, D. Appleton Century Co. Inc., 1939.

THE STUDENT'S HANDBOOK OF SURGICAL OPERATIONS. By Sir Frederick Treves, Bart. G.C.V.O. C.B. LL.D. 1 R.C.S. 6th ed. revised by Cecil F. C. Wakeley, D.Sc. F.R.C.S. F.R.S.E. 1 A.C.S. (Hon.) F.R.A.C.S. New York, Paul B. Hoeber Inc., 1939.

DER RHEUMATISMUS SAMMLUNG VON ESZELDARSTELLUNGEN AUS DEM GESAMTBEIT DER RHEUMATISCHEN KUNGEN. Edited by Prof. Dr. Rudolf Juergens. Vol. 14—CHIRURGIE UND RHEUMATISCHE ARBEITEN. By Dozent Dr. A. Fomio. Dresden and Leipzig, Theodor Steinkopff, 1939.

PRACTICAL DERMATOLOGY AND SYPHILIS. By Harry M. Robinson, M.D. Philadelphia, P. Blakiston & Son & Co. Inc., 1939.

THE PRINCIPLES AND PRACTICE OF OPHTHALMIC SURGERY. By Edmund B. Spaeth, M.D. Philadelphia, Lea & Febiger, 1939.

## CORRESPONDENCE

### THE FRANCIS AMORY SEPTENNIAL PRIZE OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES

IN compliance with the requirements of a gift under the will of the late Francis Amory of Beverly, Massachusetts, the American Academy of Arts and Sciences announces the offer of a septennial prize for outstanding work with reference to the alleviation or cure of diseases affecting the human genital organs to be known as the Francis Amory Septennial Prize. The gift provides a fund the income of which may be awarded for conspicuously meritorious contributions to the field of knowledge.

During the said septennial period next preceding any award thereof through experiment, study or otherwise in the diseases of the human sexual generative organs in general. The prize may be awarded to any individual or individuals for work of extraordinary or exceptional merit in this field.

In case there is work of a quality to warrant it the first award will be made in 1940. The total amount of the award will exceed ten thousand

dollars and may be given in one or more awards. It is sole, within the discretion of the Academy whether an award shall be made at the end of any given seven year period and also whether on any occasion the prize shall be awarded to more than a single individual.

While there will be no formal nominations and no formal essays or treatises will be required the Committee invites suggestions which should be made to the Advisory and Committee care of the American Academy of Arts and Sciences, 28 Newbury Street, Boston, Massachusetts, U.S.A.

### A TECHNIQUE OF THYROIDECTOMY PERMITTING THE USE OF SILK

#### A CORRECTION

In the article by Drs. Donald Guthrie and M. J. Brown entitled "A Technique of Thyroidectomy Permitting the Use of Silk" which appears in the April issue, p. 801, an error has been made in the names of the muscles in the text on pages 806 and 809 in the illustration and the caption of Figure 13 and in the caption of Figure 6 the word "thyroid" muscle should read "sternothyroid" muscle.

# AMERICAN COLLEGE OF SURGEONS

## A REVIEW OF THE CLASSIFICATION OF BONE TUMORS

JAMES EWING, M D, New York, New York

IN 1928, The Bone Sarcoma Registry of the American College of Surgeons prepared a classification of bone sarcomas and recommended its adoption by surgical clinics. While the classification was not entirely satisfactory to the committee, it was felt that its tentative adoption would facilitate the interchange of views and the progress of knowledge of this complex group of diseases.

The classification was as follows

- A Osteogenic Sarcoma
  - 1 Medullary and subperiosteal
  - 2 Telangiectatic
  - 3 Sclerosing
  - 4 Periosteal
  - 5 Fibrosarcoma, medullary, periosteal
  - 6 Parosteal, capsular
- B Giant Cell Tumors
- C Endothelioma
  - 1 Angiosarcoma
  - 2 Diffuse endothelioma
- D Myeloma
  - 1 Plasma cell myeloma
  - 2 Myelocytoma
  - 3 Erythroblastoma
  - 4 Liposarcoma

Liposarcoma was omitted from the original list because of scanty material, and the existence of well defined reticulum cell lymphosarcoma was not sufficiently established to warrant its recognition at that time.

This classification received rather wide approval in American clinics and its influence in foreign clinics was apparent in many subsequent contributions in this field. After this rather long interval and trial it has seemed to the committee that it should be reviewed and any changes introduced which later experience may have suggested.

During the past few years a few other classifications have been proposed and have received certain recognition, and these may be discussed here.

The committee's classification and its proposed revision are based on histogenesis, and it will be observed that this principle has been followed

rigidly throughout. The designation of subvarieties is based on pathological anatomy because this method lends itself to the practical needs of surgeon, radiologist, and pathologist. However, it is not possible to subdivide the true myelomas on pathological anatomy because gross features of the myelomas are much alike, and here the designation of subvarieties is based on histogenesis or cell of origin. These principles accord with those now employed in the classification of tumors in general and of most other pathological processes.

In 1931, Geschicter and Copeland proposed another classification, somewhat similar to the other, but based ostensibly on the embryology of bone

### TUMORS RELATED TO OSTEOGENESIS

#### A Tumors derived from precartilaginous connective tissue

##### 1

- 1 Osteochondroma or benign exostosis
- 2 Chondroma or benign chondromyxoma
- 3 Primary chondromyxosarcoma
- 4 Secondary chondromyxosarcoma

#### B Tumors related to subsequent cartilaginous growth

##### 2

- 1 Chondroblastic sarcoma
- 2 Osteolytic osteogenic sarcoma
- 3 Bone cyst and osteitis fibrosa
- 4 Benign giant cell tumor

##### 3

- 1 Primary lymphoma of bone (Endothelial myeloma of Ewing)
- 2 Multiple myeloma
- 3 Metastatic carcinoma
- 4 Fibrosarcoma and neurogenic sarcoma

There are several substantial defects in this classification. It departs radically from all previous usage and introduces new and novel conceptions which are not well established facts. It overemphasizes the participation of cartilage in bone sarcomas, five of nine subdivisions being types of chondroma or chondrosarcoma. It subordinates the important features of pathological

A Report from the Committee of the Registry of Bone Sarcoma, of the American College of Surgeons

anatomy which are of the greatest practical importance to surgeon, radiologist, and pathologist and which as a rule must form the basis of clinical diagnosis. Osteoblastic and osteolytic osteogenic sarcomas probably arise from the same cells, the rate of growth and other physiological properties determining the presence or absence of bone. The term osteolytic sarcoma invites inaccuracy and confusion, since so many different tumors of bone are osteolytic. It would seem better to recognize the osteolytic sarcomas as the higher grades of malignancy of the essential varieties rather than as a special group.

Osteitis fibrosa is not a neoplastic process except when associated with giant cell tumors. Too little attention is given to the various forms of fibrosarcoma. Nothing is gained by omitting the well defined periosteal fibrosarcoma. On the other hand the separation of neurogenic from other form of fibrosarcoma is properly emphasized. Lymphoma is too general a term to designate any of the specific tumors of bone marrow. The various subdivisions of true myeloma can hardly be omitted from any adequate list of tumors of bone marrow. Endothelioma was probably assigned to the lymphoma class because of inadequate data.

On the other hand the questions raised by these authors emphasize the need of a special grouping of the series of cartilaginous tumors, and also the probable participation of embryological disturbances in the origin of certain sarcomas of bone.

Another classification has been recently suggested by Dahl<sup>1</sup>:

- A  
 1. Periosteal or sclerosing sarcoma  
 2. Periosteal chondromyxosarcoma  
 3. Central osteolytic sarcoma  
 4. Central osteolytic chondroblastic sarcoma  
 B. Endothelioma (Ewing's sarcoma)  
 C. Myeloma  
 D. Periosteal fibrosarcoma  
 E. Osteitis fibrosa and sequel.

This classification emphasizes certain clinical and pathological features which are undoubtedly of interest such as the variations in structure of tumors in or under the periosteum, the osteolytic property of certain cartilaginous tumors and the separate position of osteitis fibrosa and its sequel. Yet we cannot see the grounds for separating between periosteal fibrosarcoma and periosteal sclerosing sarcoma. Sclerosing sarcoma is a term firmly attached to the central sclerosing osteogenic sarcomas. When cartilage forms in tumors connected with periosteum the cartilage seems to

arise from the underlying bone and not from the periosteum proper. Central osteolytic tumors are of several types. The response to Dahl's classification is not apparent.

#### COMMENTS ON THE COMMITTEE'S CLASSIFICATION

Considerable discussion has occurred regarding the validity of the term "osteogenic" to designate tumors derived from bone. It has been asserted that this term may signify only "producing bone." Yet Webster's dictionary (1937) defines osteogenic as meaning "originating in bone." This is exactly the sense in which that term is employed in the committee's classification. There are other familiar instances in which the same use is made of the suffix genetic, as hematogenous jaundice, bronchiogenic carcinoma, etc.

The term osteosarcoma was rejected as unsatisfactory as a general term because it has long been identified with bone production and applied more specifically to the bone forming sarcomas and particularly to the sclerosing forms.

Medullary and subperiosteal osteogenic sarcoma is the term applied to the typical form of bone sarcoma which arises from the shaft of the bone and grows freely into the marrow cavity and also underneath the periosteum. It lifts the periosteum and produces the characteristic triangle of Codman. The committee endorses the use of this term as accurately reflecting the origin of the tumor and meeting the needs of pathological anatomist, surgeon and radiologist. Sclerosing osteogenic sarcoma has been recognized as one of the best defined types of bone tumors ever since its original description by Virchow. Periosteal sarcoma of spindle cell structure varying grades of malignancy, absence of bone production and peculiar metastatic tendencies presents such notable specific features as to require recognition as a separate type of bone sarcoma. The origin from the outer layer of the periosteum and preservation of the shaft serve to distinguish it roentgenographically from the destructive forms of bone tumors. The Registry now contains several cases which emphasize the remarkable prediction of this tumor to produce multiple metastases in the periosteum of many other bones, a feature rather exclusively enjoyed by this process and suggesting peculiar physiological properties. Very wide differences in grades of malignancy are presented in this group, some being fibrous, others large spindle cell, and many very small spindle cell structures with increasing malignancy and metastatic powers.

The medullary fibrosarcomas constitute a limited group of processes the exact nature ori-

<sup>1</sup>Dahl Norsk Magt 1. 1937 98, 410.

REVISED CLASSIFICATION OF BONE TUMORS 1939

	Malignant	Benign
1 Osteogenic series	1. Medullary and subperiosteal	1 Exostosis
Osteogenic sarcoma	2 Telangiectatic	2 Osteoma
	3 Sclerosing	
	4 Periosteal	
	5 Fibrosarcoma	
	(a) Medullary	
	(b) Periosteal	
2 Chondroma series	6 Parosteal, capsular	1 Chondroma
	1 Chondrosarcoma	
	2 Myxosarcoma	
3 Giant cell tumor series	1 Malignant	1 Epiphyseal giant cell tumor
4 Angioma series	1 Angioendothelioma	1 Cavernous angioma
	2 Diffuse endothelioma	2 Plexiform angioma
5. Myeloma series	1 Plasma cell	
	2 Myelocytoma	
	3 Erythroblastoma	
	4 Lymphocytoma	
6. Reticulum cell lymphosarcoma		
7. Liposarcoma		

gin, and relations of which require further study, but the existence of peculiar tumors of this type, not related to any other medullary process, such as central chondroma or endosteal proliferation, must be conceded. The Registry contains a few such cases which have been recognized as peculiar but have been passed over without any serious attempt at elucidation. Very widespread lesions of this type have been observed. A possible connection with Paget's disease has been suggested.

Steiner has registered a remarkable case of diffuse spindle cell medullary fibrosarcoma affecting chiefly pelvis and sternum but appearing in other bones and associated with peculiar fibrosarcomatous lesions in several organs. A possible relation to Paget's disease, or neurofibrosarcomatosis, may be considered in explanation of such conditions, as of other medullary fibrosarcomas.

Capsular and parosteal sarcomas may with difficulty be given admission to the elite group of osteogenic sarcomas. They arise from fibrous capsules of joints and deep fasciæ, often produce bone and cartilage, and may be intimately attached to the bone, but they do not originate from true bone tissue. Practically it may be very difficult for surgeon or radiologist to detect their spurious claims. The capsular tumors must be distinguished from fibrocellular synoviomias and chondromas. The fibrous, cartilaginous, osseous or cellular fascial sarcomas of Virchow belong with the parosteal group, but the deep intermuscular myxosarcomas do not, although they may contain metaplastic areas of cartilage. Various forms of bony metaplasia may be seen in the deep neurofibrosarcomas, which compose the majority of parosteal sarcomas.

Telangiectatic bone sarcoma, a form of malignant bone aneurism, is a very characteristic bone tumor, but its exact origin and relation to other bone sarcomas have not been satisfactorily determined. There is considerable evidence suggesting that this process belongs with the tumors of blood vessels of bone and is a cavernous angiosarcoma, and that the rich proliferation of malignant cells and scanty atypical bone deposits are to be interpreted as phases of reactive productive osteitis. Typical cases, such as those depicted in *Neoplastic Diseases*<sup>1</sup>, are not common in the Registry. These tumors tend to remain circumscribed, some are very malignant and destructive, producing no bone, while a few grow more slowly and lay down some reactive bone. There seem to be transitional stages between benign aneurismal giant cell tumors and the cases now being classed as vascular osteogenic sarcoma. Further data seem necessary before the true nature and relations of the so called telangiectatic bone sarcoma can be determined, and these data should relate to the part played by blood vessels in the origin and growth of other osteogenic sarcomas. Their intimate clinical connections with other malignant bone tumors seem to warrant their retention, for the present, in any complete grouping of bone sarcomas.

*Cartilaginous bone sarcomas.* Considerable basis exists for the recognition of a special group of bone tumors derived from cartilage and producing cartilage. These tumors arise from pre-existing normal cartilage or from remnants of cartilage displaced by rickets, or from chondromas or ecchondroses. The growths tend to be bulky and



they may reach very large dimensions. In the roentgenogram they are usually circumscribed, multilobed, and translucent and very opaque calcific deposits are characteristic. All these features have been emphasized especially by Pheemister.<sup>1</sup> There are many structural varieties and all grades of malignancy. Some resemble normal hyaline cartilage and are benign, others cellular with mucinous and cystic degeneration, many exhibit a typical scanty matrix, many cells and definite malignancy, a few show advanced or complete mucinous degeneration yielding pure myxosarcomas. Calcification overtakes some areas in many tumors of this type, and giant cells of epulis type appear in certain cases. Cartilaginous material may be entirely missing in malignant tumors derived from cartilage, in which case the cells show a peculiar polyhedral or epithelioid form. The benign calcifying giant cell tumor of the head of humerus, previously mentioned, may well belong in this group of calcifying degenerating chondromas. The periosteal and the medullary myxosarcomas are probably of cartilaginous origin. If the cartilaginous series of tumors is to be separated from other osteogenic sarcomas, the list would include the following forms:

A Benign enchondrosis, chondroma and osteochondroma, periosteal and medullary

B Chondrosarcoma

C Myxosarcoma

*Giant cell tumors.* It can hardly be said that the accumulated efforts of surgeons, radiologists, pathologists, endocrinologists, and chemists, during the past decade have succeeded in simplifying our interpretation of the complex group of processes included under this term. Probably the outstanding contribution is the proof that single and often multiple typical giant cell tumors are dependent on the mobilization of calcium from the bones under the influence of parathormone secreted in excess by overactive and generally hyperplastic parathyroid glands. Whether solitary giant cell tumors of identical structure and behavior are also the sequels of previous but transient disturbance of calcium metabolism is less certain but would seem to be a reasonable assumption. In that case the great majority of giant cell tumors would fall readily in one grand class without too much regard to minor differences of structure and clinical behavior. Against this simple solution lies the fact that many observers have noted definite and apparently primary changes in the blood vessels of bone and have attributed the giant cell reaction to the sequels of an angiomatous process. The promi-

nence of blood vessels was noted by early students of giant cell tumors and recently Pühr has likened these early stages to cavernous angioma of the liver (and to the so called hemangiomas). In a well known group of giant cell tumors the gross structure is much like that of benign cavernous angioma, in which the giant cell reaction is merely a sequel of the absorption of bone by the angioma. It would seem possible that such low grade angiomatous processes might follow calcium absorption dependent primarily on parathyroid disturbances but this explanation applies less readily to the more active vascular tumors. In some giant cell tumors, the blood vessels are not prominent and the tumor is solid and cellular. While a traumatic history is often obtained in cases of giant cell tumor, a traumatic origin has not been satisfactorily proved and attempts to produce such tumors of bone by trauma have failed. Whatever may be the true pathogenesis of giant cell tumors the main group remains quite compact and characteristic and varies chiefly in grade of malignancy. It is now readily apparent that there are all grades of malignancy among giant cell tumors and that in certain not infrequent cases the structure changes from a benign to a malignant type, especially after curettage or interstitial radiation, and sometimes in the normal course of very prolonged cases.<sup>2</sup> Some of the tumors are malignant from the first and some become so and since it is highly important to recognize such variations, the best plan would seem to be the adoption of the simple method of grading the tumors in the usual manner according to degrees of malignancy. Grade 1 would then signify the benign simple essentially inflammatory process which many authors have refused to recognize as neoplastic. Grade 2 would designate the ordinary benign but progressive cases. Grade 3 would refer to the aggressive cellular forms with scanty giant cells and grade 4 the primary atypical hyperchromatic large spindle cell and giant cell malignant metastasizing growths of which there are now not a few cases on record. Aneurysmal growths do not fall into this scheme and may be specially designated.

There remain several variants or related forms of benign medullary tumors with giant cells which are not so easily disposed of. Certain benign circumscribed spindle cell myxosarcomas with few or no giant cells are observed which run the usual course of giant cell tumors and should probably be included in this group.

The benign calcifying giant cell tumors of the head of the humerus and occurring in other bones

reported at the International Cancer Congress in London, 1928, and first fully described by Codman,<sup>1</sup> are characteristic benign processes, generally mistaken for malignant osteogenic sarcomas and treated as such by amputation, whereas they are readily cured by radiation. In order to avoid this unfortunate error it is desirable that this peculiar tumor should receive special recognition and a distinguishing designation. The structure presents strands of calcifying cartilage, cords of small polyhedral cells, and a moderate number of giant cells. As emphasized by Geschichter and Copeland, giant cells also occur in malignant chondrosarcomas in this and other regions, and these tumors must be distinguished histologically from the benign process here described.

*Endothelioma (Ewing's sarcoma)* The existence of a specific variety of bone sarcoma of this general type has been widely accepted but its histogenesis is still under active debate. Oberling and Raileanu<sup>2</sup> and others have presented evidence to show that this tumor arises from the reticulo-endothelial system and that the tumor cells exhibit capacity to differentiate into plasma cells, myelocytes, lymphocytes, and even erythroblasts. According to this view, the tumor represents a form of totipotent myeloma capable of forming any one of the specific types of myeloma. This interpretation seems to have been rather widely accepted in Europe.

The writer cannot accept this view and believes that the eminent French investigators have failed to distinguish between a specific type of endothelial tumor and other rarer round cell myelomas among which may probably be some that arise from the hematopoietic cell system or indifferent lymphoid reticulum cells. The writer believes that the typical endothelioma of bone arises from capillary endothelium and never exhibits any other properties than those belonging to vascular endothelium. The pseudo-rosettes, the characteristic perithelial structures, and the cords of polyhedral cells lining elongated spaces are the outstanding structural features of this tumor and they never appear in any tumor derived from hematopoietic cells or reticulum cells. Plasma cells, granular leucocytes and lymphocytes are notably absent from tumors presenting these features, and when they are present the tumor should be excluded from the group of endothelioma. Moreover, in many cases of endothelioma there are associated with the above structural features, dilated blood channels of various sizes composed

of the typical tumor cells, disclosing the angioblastic properties of the cells and connecting the tumor with other angiomas or angiosarcomas. Similar features are observed in capillary angiosarcomas of other organs, notably the skin.

According to the present available observations, it seems desirable to recognize a special class of bone tumors arising from blood vessels, with varying structure and degrees of malignancy, as follows:

- A. Cavernous angioma
- B. Plexiform angioma (sun-ray radiological type)
- C. Angio-endothelioma, with fine blood channels lined by single rows of endothelial cells
- D. Diffuse endothelioma, with pseudorosettes, and perithelial units, (Ewing's sarcoma).

The contribution of Oberling and Guerin is important in emphasizing the variety of cell types which appear in true myelomas of the hematopoietic series and attention to which may permit the more accurate separation between true myelomas arising from specific marrow cells, and endothelioma arising from the capillary endothelium of bone tissue.

*Myeloma* The group of true myelomas, arising from specific marrow cells, not connected with bone, remains an alluring and difficult field for histological exploration, but the main varieties of these neoplasms have become more firmly established during the past decade. The chief contribution has been that of Oberling and Raileanu, who have furnished substantial basis for the recognition of a group of reticulum cell sarcomas, or lymphosarcoma. They have also apparently shown that some tumors arising from the reticulum cells of the bone marrow may differentiate toward plasma cell, or lymphocytic, or myelocytic, or erythroblastic subvarieties. Yet all observers have not accepted this wide potency of the simple reticulum cell of the bone marrow, and certainly the main varieties of myeloma previously recognized, are generally quite distinct. These varieties are, plasma cell myeloma, myelocytoma, lymphocytoma, erythroblastoma. The existence of a pure reticulum cell lymphosarcoma of bone marrow was recognized many years ago by Kaufmann. He stated that the cells were larger than plasma cells, resembled large or small reticulum cells, with giant cells, and a reticular matrix was present. Craver and Copeland<sup>3</sup> have reported 16 cases of this class, in some of which the disease was primary in the bone marrow, the patients did not suffer from cachexia or anemia of myeloma but were generally in fair condition

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they may reach very large dimensions. In the roentgenogram they are usually circumscribed, multilobed, and translucent and very opaque calcific deposits are characteristic. All these features have been emphasized especially by Phemister.<sup>1</sup> There are many structural varieties and all grades of malignancy. Some resemble normal hyaline cartilage and are benign, others cellular with mucinous and cystic degeneration, many exhibit a typical scanty matrix, many cells and definite malignancy, a few show advanced or complete mucinous degeneration yielding pure myxosarcomas. Calcification overtakes some areas in many tumors of this type and giant cells of epulis type appear in certain cases. Cartilaginous material may be entirely missing in malignant tumors derived from cartilage, in which case the cells show a peculiar polyhedral or epithelioid form. The benign calcifying giant cell tumor of the head of humerus previously mentioned may well belong in this group of calcifying degenerating chondromas. The periosteal and the medullary myxosarcomas are probably of cartilaginous origin. If the cartilaginous series of tumors is to be separated from other osteogenic sarcomas, the list would include the following forms:

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until shortly before death, the usual extensions of the disease to lymph nodes was observed and the structure was that of pure reticulum cell sarcoma. Parker has described a series of such cases primary in the bone marrow.

The committee therefore recommends the recognition of pure reticulum cell lymphosarcoma and urges the further study of this entire group along the lines pursued by Oberling and Raileanu. The committee is inclined to exclude this tumor from the group of true myelomas.

Since the report of liposarcoma of bone marrow in 1928 (London Cancer Congress), there have been few examples of this characteristic malignant tumor recorded, but enough to warrant its recognition in the present classification. Since it has no connection with specific marrow cells, the committee would exclude it from the group of true myelomas. Stewart<sup>1</sup> has reported in detail one case and another has been reported by Rehbock and Hauser. This tumor is probably more frequent than is now recognized.

The main results of the present review may be stated as follows. The validity and practical value of the classification originally proposed by the committee are in general, confirmed, but certain changes and additions are required to meet observations made during the past decade.

The introduction of a separate group of tumors derived from cartilage and producing cartilage is theoretically justified and would be of practical advantage. A new group of tumors of blood vessels is introduced and diffuse endothelioma is assigned to this group.

Malignant giant cell tumors are recognized, and their occasional occurrence is emphasized. Epiphyseal giant cell tumors generally running a benign course are given a special entry.

The group of myelomas is limited to those tumors arising from specific marrow cells.

Reticulum cell lymphosarcoma arising in bone marrow is accepted as a well established variety.

Liposarcoma, arising from the fat cells of bone marrow is accepted as a definite entity.

The benign tumors of bone are included in the classification.

Secondary tumors of bone are excluded although the claims of certain neurosarcomas and of adamantinoma may be noted.

A review for the literature on bone sarcoma of the past decade reveals the fact that we are still struggling with the complexities of simple pathological anatomy and histology and that there are few attempts to penetrate the field of etiology and pathogenesis. The accurate diagnosis of a bone sarcoma remains a rather difficult task. There is little doubt that the adoption of an adequate classification of these tumors, with as many subdivisions as necessary, would be a distinct step forward. Unless the surgeon and pathologist are familiar with what may happen in the bone, he is hardly able to recognize what has happened. Yet the time would seem to have arrived when more definite efforts should be made to investigate the etiology of these processes by all means available. The recognition that giant cell tumors may be the sequel of parathyroid hyperactivity, and that malignant bone sarcomas inevitably result from the deposit of radium in the bones are outstanding contributions, which point the way to further investigations. Studies of the relation of phosphatase to bone growth have also thrown some light into a very obscure field and should be pursued further. The subject of traumatic bone sarcoma has made little progress but it would seem very desirable that no report of a supposed traumatic bone sarcoma should receive a hearing unless the case has been rigidly scrutinized according to recognized medical criteria. No one has produced a bone sarcoma by trauma. The relation of infection to bone tumors has seldom been considered but many such tumors are infected from the start. Some very interesting instances of two or even three bone sarcomas in the same family have been reported. Accordingly the Registry Committee is disposed to limit the registration of cases in the future to those which present some unusual and instructive feature or in which special studies have been made in the field of etiology.

Stewart, Am. J. Path. 29:1, p. 87.  
Rehbock and Hauser, Am. J. Cancer 1926 27: 37.

## PLANS FOR 1939 CLINICAL CONGRESS IN PHILADELPHIA

THE American College of Surgeons announces the twenty-ninth annual Clinical Congress when the surgeons, medical schools, and hospitals of Philadelphia will be hosts to interested visitors from all parts of the United States and Canada during the five days October 16-20. Preparations for the meeting are being carried forward under the leadership of a representative committee of Philadelphia surgeons.

This group is assured of the full co-operation of the clinicians at the five medical schools and more than forty hospitals that will participate in the clinical program. There will be provided an ample and well arranged schedule of operative clinics demonstrating the technique of a wide variety of surgical procedures. The committee also plans to arrange a series of symposia and demonstration clinics at the medical schools and in the larger hospitals for the presentation of all phases of the work which is being done in general surgery, neurosurgery, traumatic surgery, thoracic surgery, plastic surgery, orthopedic surgery, genito-urinary surgery, obstetrics and gynecology, and other allied specialties. The programs will be so correlated that the visiting surgeon may be assured of an opportunity to devote his time continuously to clinics dealing particularly with the special subjects in which he is most interested. The final program will be published and classified according to the various specialties in order to aid the visiting surgeon in the selection of the clinics which he desires to attend.

A preliminary schedule of the operative clinics and demonstrations is being prepared by the committee for publication in the June issue of *SURGERY, GYNECOLOGY AND OBSTETRICS* and the *Bulletin* of the College. Clinics will be arranged for each day of the meeting beginning Monday afternoon and continuing each morning and afternoon of the following four days. All departments of surgery will be represented therein.

The Executive Committee of the Board of Regents is preparing programs for the scientific sessions to be held each evening. At the opening meeting on Monday evening the retiring president, Dr. Howard C. Naffziger, of San Francisco, will deliver the Presidential Address, and the new officers—Dr. George P. Muller, of Philadelphia, president, Dr. Henry W. Cave, New York, and Dr. D. Edwin Robertson, Toronto, vice-presidents—will be inaugurated. The 1939 class of in-

mates will be received into fellowship at this meeting. On Tuesday, Wednesday, and Thursday evenings eminent surgeons of the United States and Canada, together with a number of visiting surgeons from foreign countries, will present and discuss papers dealing with surgical subjects of timely importance.

Special attention is being given by sub-committees on ophthalmology and otolaryngology in arranging complete programs on these subjects. It is planned to hold clinical demonstrations at headquarters each morning and operative clinics and demonstrations at the local hospitals in the afternoons for those interested in these specialties. Evening sessions will also be held at headquarters, at which visiting ophthalmologists and otolaryngologists will present papers of special interest.

Other features of the 1939 Clinical Congress will include afternoon conferences and symposia dealing with cancer, obstetrics and gynecology, fractures and traumatic surgery, urology, and other subjects. An extensive series of round-table conferences are to be held at headquarters each day. These conferences will cover a wide variety of important subjects of vital interest.

The annual hospital conference will open the Congress with a session at 10 o'clock on Monday morning when the approved list of hospitals, cancer clinics and medical services in industry will be announced. A list of hospitals approved for graduate training in surgery will also be announced at this meeting. In keeping with the importance of these programs of the College, there will be held a series of round table conferences and practical demonstrations, both at headquarters and in the local hospitals, dealing with the many problems related to hospital efficiency, management, and education. It is proposed to make this year's session of wide interest and practical character through a careful selection of subjects to be presented and discussed by surgeons and hospital executives. Particular emphasis will be directed toward the educational programs of hospitals in the training of surgeons.

Headquarters for the Congress will be established at the Bellevue-Stratford Hotel where the several meeting rooms on the top floor have been reserved for conferences, symposia, and clinical assemblies. The evening scientific sessions will be held at Irvine Hall on the campus of the University of Pennsylvania, for which special bus transportation is being arranged.

The Technical Exhibition will be located on the first floor in the Grand Ballroom its large foyers, and adjacent rooms. Here also will be placed the registration and clinic ticket bureaus, and the bulletin boards on which the daily clinical program for the following day, will be posted each afternoon. Leading manufacturers of surgical instruments, x-ray equipment, operating room lights, hospital apparatus of all kinds, ligatures, dressings, pharmaceuticals, and publishers of medical books will be represented.

The hospitals and medical schools of Philadelphia afford accommodations for large numbers of visiting surgeons, but to insure against overcrowding attendance at the Congress will be limited to a number that can be comfortably accommodated at the clinics. It is expected and urged therefore, that those surgeons who wish to attend the Congress will register in advance.

A registration fee of five dollars is required of each surgeon attending the Clinical Congress. A formal receipt for the fee is issued to each surgeon registering in advance, which receipt is to be exchanged for general admission card upon his registration at headquarters. This card is non-transferable and must be presented in order to secure clinic tickets and for admission to the evening meetings and other scientific sessions.

Admittance to clinics and demonstrations at the hospitals will be controlled by means of special clinic tickets. Such a plan provides the only efficient means for the distribution of the visiting surgeons among the several clinics and insures against overcrowding as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic is given.

## COMMITTEE ON APPANGEMENTS

### EXECUTIVE COMMITTEE

Thomas A. Shallow	Robert H. Ivy
Chairman	Chevalier L. Jackson
Lewis K. Ferguson	Richard H. Meade
Secretary	Thaddeus L. Montgomery
William Bates	J. T. Nicholson
W. E. Burnett	John Paul North
Edward L. Campbell	Huhley R. Owen
J. Montgomery Deaver	Franklin L. Payne
Everett H. Dickinson	Warren S. Reese
Gilson C. Engel	Frederick R. Robbins
Theodore R. Fetter	Thomas J. Ryan
Kenneth F. Fry	Calvin M. Smyth Jr.
Ralph Goldsmith	Margaret Sturgis
Francis Grant	

### HOSPITAL REPRESENTATIVES

Abington—J. Walter Levering  
 American Hospital for Diseases of the Stomach—Herbert R. Hawthorne  
 American Oncology—George M. Dorrance  
 Broad Street—Theodore C. Feary  
 Bryn Mawr—J. Stewart Rodman

Chestnut Hall—William C. Sheehan  
 Children's—Ernest G. Williamson  
 Cooper (Camden N. J.)—Irvin E. Deibert  
 Delaware—Drury Hinton  
 Fitzgerald Mercy—Thomas J. Ryan  
 Franklin—Louis D. Engleth  
 Germantown—William B. Swartley  
 Graduate—William Bates, Benjamin H. Shuster, Luther C. Peter, Harry L. Farrell  
 Hahnemann—Herbert P. Leopold, Frank O. Nagle, John A. Brooke, Newlin F. Paxson  
 Jeanes—Roscoe W. Teahan  
 Jefferson—Thomas A. Shallow, Louis H. Clerf, Charles R. Heed  
 Jewish—Ralph Goldsmith, Phillip F. Williams  
 Kensington—Edward A. Schumann  
 Laekenau—Gilson C. Engel  
 Memorial—Bruce L. Fleming  
 Methodist Episcopal—Calvin M. Smyth, James B. Mason  
 Misericordia—Francesco Mogavero  
 Mt. Sinai—Benjamin Lipschutz  
 Northeastern—T. Turner Thomas  
 Northern Liberties—Norman S. Rothschild  
 Pennsylvania—Walter Estell Lee, John B. Fick, F. R. Robbins  
 Philadelphia General—V. W. Murray, Wright Robert Hunter, John C. Howell, I. S. Hineleksi  
 Philadelphia Lying In—Norms W. Vaux  
 Philadelphia Orthopedic—DeForrest P. Willard  
 Presbyterian—J. Paul North  
 Preston Retreat—John Cooke Hirst  
 Joseph Price Memorial—James W. Kennedy  
 Protestant Episcopal—Richard H. Meade Jr., Otto C. Hirst, Andrew Knox  
 St. Christopher's—Harry E. Knox  
 St. Joseph's—Verne G. Burden  
 St. Luke's and Children's—Denden Roman  
 St. Mary's—James A. Kelly  
 St. Vincent's—William F. Morrison  
 Shroers—John R. Moore  
 Stetson—Robert S. Alston  
 Temple University—W. Wayne Babcock, W. I. Lillie, Robert F. Rudolph  
 University of Pennsylvania—J. S. Ravdin, Harry P. Schenck, Francis H. Adler, Franklin L. Payne  
 U. S. Naval—F. L. Conklin  
 West Jersey Homeopathic (Camden N. J.)—E. S. Haltinger  
 Wills—Warren S. Reese  
 Woman's Homeopathic—Francis L. Hughes  
 Woman's—Margaret Sturgis  
 Woman's Medical College—S. Faith Fetterman, James Lehman

**SUB COMMITTEES**

Bronchos E. ophagocopy—Chevalier L. Jackson, Chairman  
 General Surgery—Huhley R. Owen, Chairman  
 Genito Urinary Surgery—Theodore F. Fetter, Chairman  
 Alexander Randall  
 Industrial Surgery—William Bates, Chairman  
 Neuro-Surgery—Francis Grant, Chairman  
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 Ophthalmology—Warren S. Reese, Chairman  
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 Otolaryngology—Edward L. Campbell, Chairman  
 Plastic Surgery—Robert H. Ivy, Chairman  
 Publicity—Kenneth E. Fry, Chairman  
 J. Montgomery Deaver, Richard H. Meade  
 Thoracic Surgery—W. Emory Burnett, Chairman





The Technical Exhibition will be located on the first floor in the Grand Ballroom, its large foyers, and adjacent rooms. Here also will be placed the registration and clinic ticket bureaus, and the bulletin boards on which the daily clinical program for the following day will be posted each afternoon. Leading manufacturers of surgical instruments, x-ray equipment, operating room lights, hospital apparatus of all kinds, ligatures, dressings, pharmaceuticals, and publishers of medical books will be represented.

The hospitals and medical schools of Philadelphia afford accommodations for large numbers of visiting surgeons, but to insure against overcrowding, attendance at the Congress will be limited to a number that can be comfortably accommodated at the clinics. It is expected and urged, therefore, that those surgeons who wish to attend the Congress will register in advance.

A registration fee of five dollars is required of each surgeon attending the Clinical Congress. A formal receipt for the fee is issued to each surgeon registering in advance, which receipt is to be exchanged for general admission card upon his registration at headquarters. This card is non-transferable and must be presented in order to secure clinic tickets and for admission to the evening meetings and other scientific sessions.

Admittance to clinics and demonstrations at the hospitals will be controlled by means of special clinic tickets. Such a plan provides the only efficient means for the distribution of the visiting surgeons among the several clinics, and insures against overcrowding as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic is given.

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# SURGERY

## GYNECOLOGY AND OBSTETRICS

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### THE SURGICAL TREATMENT OF CHRONIC CONSTRICTIVE PERICARDITIS

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New York, New York

IN previous communications<sup>1</sup> the authors presented a study of the circulation in 9 patients with chronic constrictive pericarditis. At the time, 6 of the 9 patients had been subjected to the operation of decortication of the heart so that it was possible in two-thirds of the number to compare the measurements of the circulation before and after the heart had been partially freed of its constricting envelope. Briefly, it was found in this group of patients that the arteriovenous oxygen difference was increased, the venous pressure elevated, and the circulation time prolonged, while the cardiac output per minute, the stroke volume, and the cardiac index (cardiac output in liters per square meter of body surface per minute) were diminished. In the 6 patients subjected to subtotal pericardiectomy, these values tended to, or actually did, return to normal. The plan followed in making these observations and the methods employed are detailed in these communications. These observations have added to our knowledge of the pathological physi-

ology of a disease which, in this country, has been studied particularly by White, White and Churchill, Beck and his associates, and Burwell and Blalock. The clinical manifestations of this syndrome have been well described by White, and it may be of interest again to bring together briefly the symptoms and physical signs which have contributed toward our recognition of this disease.

The diagnosis of chronic constrictive pericarditis should be considered in the presence of signs of congestive heart failure not associated with the common etiological causes. Organic valvular lesions have conspicuously been absent. Enlargement of the liver and ascites usually are present. Edema of the extremities and pleural effusions occur, but less frequently. Distention of the peripheral veins is a constant finding. The cardiac silhouette may be small, approximately normal, or moderately large. The paradoxical pulse has been present in every case in our experience. The pulse usually is small in volume, the blood pressure and pulse pressure low. The point of maximal impulse of the heart may not shift. Under the fluoroscope, decrease in or absence of motion of the several chambers of the heart may be observed, and absence of shifting of the heart may be confirmed. Calcification of the pericardium may

From the Surgical and Medical Departments of the New York Hospital and Cornell University Medical College.

The studies reported in this paper formed the basis of the 15th Arthur Dean Bevan Lecture in Surgery, given by one of us (G. J. H.) in Chicago, Illinois, October 7, 1938.

<sup>1</sup>Stewart, H. J., Heuer, G. J., et al. *J. Clin. Invest.*, 1938, 17: 581; Stewart, H. J., and Heuer, G. *J. Arch. Int. Med.* (in press).



Painting by Louis Bettis

## Charles H. Mayo

BORN JULY 19, 1865—DIED MAY 26, 1939

tissues and body cavities had been removed as much as possible.

#### ANESTHESIA

Of the 7 patients subjected to operation, 4 were anesthetized by the simple open drop ether method, 2 with drop ether administered through an intratracheal tube (Magill) and 1, with an ethylene-oxygen-ether mixture. All the anesthetics were smooth, satisfactory, and without cyanosis. In 3 of the 5 patients in whom the intratracheal method was not employed, the left pleura was slightly torn in exposing the pericardium. The small openings were immediately closed with fine silk and neither cardiac nor respiratory upsets occurred as a result of these misadventures. In the 2 cases in which the intratracheal method was used, the pleura was not torn. In all cases the pulse was rapid, ranging between 100 and 160, in the majority being 130 or over. It was usually not only rapid but in 2 cases irregular in rhythm. On the other hand, the respiration remained regular, adequate, and unaccompanied by cyanosis. While our experience is too limited to compare different methods of anesthesia in the operation of pericardiectomy, it can be said that ether has been highly satisfactory. In no case did we have the slightest anxiety regarding this part of the procedure. While we did not use intratracheal anesthesia in the majority of cases and our patients failed to suffer any ill effects from the slight opening of the pleura in 3 instances, we are inclined to think that intratracheal anesthesia is desirable. Our experience would indicate that in spite of the greatest care, the left pleura particularly is likely to be opened in exposing the pericardium for resection; and that the opening might be sufficiently large to cause respiratory embarrassment.

In reviewing the literature on this phase of the subject it appears that Schmieden, who has had the largest experience of any single individual abroad, favors local anesthesia. He is of the opinion that the difficulties of the operation are greatly diminished by its use and it is well tolerated by the patient since the pericardium and cardiac musculature are completely insensitive. Churchill favors intra-

tracheal ether anesthesia, believing it desirable to employ general rather than local anesthesia because of the magnitude of the operative procedure and the possibilities of tearing the heart muscle and opening one or both pleural cavities. Beck raised the question whether the exposure of the heart and great vessels to atmospheric pressure was not harmful and concluded from his experimental work that this "pneumocardiac tamponade" caused a dangerous reduction in cardiac output. As a result he suggested a revival of the Sauerbruch negative pressure chamber in operations of this sort. Beck's view that failure of the peripheral circulation due to a reduced filling of the heart is a dangerous aspect of the operation is opposed by that of Churchill who finds that the real hazard of the operation lies in the possible overfilling of a weakened heart suddenly released from the support of its surrounding pericardium. Mindful of the two views we have, in our 7 cases, made particularly careful observations during the course of the operative procedure when the heart and great vessels were exposed to atmospheric pressure. We have been unable to determine that such exposure during the operation was harmful. On the other hand, the rapid enlargement of the heart after the removal of the pericardium, causing it to herniate through the pericardial defect, has been at times distinctly disquieting and has caused us to fear that the heart was being subjected to too great a strain. Churchill operates with patients in the semi-sitting position and keeps them semi-upright during their convalescence with the idea of reducing the venous return to the heart during and immediately after operation. In 7 patients we have seen no ill effects from a recumbent position during the operation and postoperative period. Nevertheless, we think that Churchill's point is well taken; and certainly conditions should be such as to permit changes in the position of the patient on the operating table and in the wards.

A study of the cases reported in the literature shows, as previously noted, that of the 143 patients subjected to operation, 19 died upon the operating table and 28 died during the immediate postoperative period. Of the former, some data regarding the cause of

be seen, or special x ray studies, particularly lateral views may be necessary to demonstrate it. The electrocardiograms are of low voltage of the QRS and T waves, and the latter may be "cove" in form in leads I and II. The electrical axis may not shift or may shift only slightly, but too much emphasis is not to be placed upon this finding. There may be slight left or slight right axis deviation. Normal sinus rhythm is usually present although auricular fibrillation may occur. Since 3 of our patients were observed during the stage of acute pericarditis with pericardial effusion and followed through the successive stages of absorption of fluid and constriction of the pericardium, this sequence of events probably is not uncommon. Patients with pericardial effusion in the absence of rheumatic heart disease should be kept under observation in order to detect the development of constrictive pericarditis. Tuberculosis as a cause of the disease was proved in only 1 of the 7 patients subjected to operation. We have already called attention to the pathological physiology of the circulation in this disease.

The surgical treatment of chronic constrictive pericarditis dates back to 1913 when Rehn and Sauerbruch both resected the pericardium for this disease. Schmieden followed their lead in 1918 and has not only maintained his interest in the surgical aspect of this condition, but has stimulated other surgeons abroad. In this country, Churchill in Boston was the first to perform the operation, and he Beck in Cleveland, and Blalock in Nashville, have shown particular interest in the subject. While the results of surgical treatment undoubtedly are striking, a study of the cases of patients subjected to surgery as reported in the literature shows that the primary mortality following decortication of the heart is still high (33 per cent). Of the 143 cases we have assembled (exclusive of our own) 19 died upon the operating table and 28 died during the immediate postoperative period, in short one third of the entire number subjected to operation. It becomes, then of importance to discover, if possible the factors concerned in the immediate mortality as well as those which influenced the late results. It is with the hope of adding to the general

knowledge of the surgical treatment of chronic constrictive pericarditis that we report our own experiences and our study of the literature. We shall omit further reference to the historical aspects of the subject which have been covered so ably by White.

Of the 9 patients with chronic constrictive pericarditis whom we have studied, 7 have been subjected to the operation of pericardiectomy. All the patients have recovered from operation. Three patients are cured in the sense that their symptoms and signs have disappeared and they are able to lead normal active lives, 3 patients are markedly improved and 1 patient is improved although sufficient time has not elapsed accurately to evaluate the results of operation.

#### PRE OPERATIVE TREATMENT

The pre operative medical treatment we have used is similar to that in the treatment of heart failure due to other causes. The patients are kept in bed, given a low salt diet (20 grams daily) and a limited amount of fluids (1200 cubic centimeters). A high protein diet has been given because it was indicated in 2 patients due to the low value of their serum proteins and because in the others, it seemed advisable to maintain the level of the serum proteins in order to hold fluids in the blood stream. Of the drugs used to mobilize fluids, mercupurin has been found to be the most satisfactory. It usually is given in 20 cubic centimeter doses intravenously at 3 day intervals. To some patients ammonium chloride 3 grams per day, was given at the same time to enhance the diuretic effect. Theocalcium 4.5 grams daily, urea, 30 cubic centimeters of a 50 per cent solution, twice daily and amino phyllin 0.1 gram three times per day were all tried but with less effect. From our observations the use of digitalis appears to be contra indicated in the medical treatment of these patients. Nevertheless, it seems necessary in those patients exhibiting auricular fibrillation to give this drug in adequate amounts to keep the ventricular rate slow. Abdominal and thoracic paracenteses were resorted to when fluid could not be removed by other measures. Patients were not subjected to operation until fluids accumulated in the

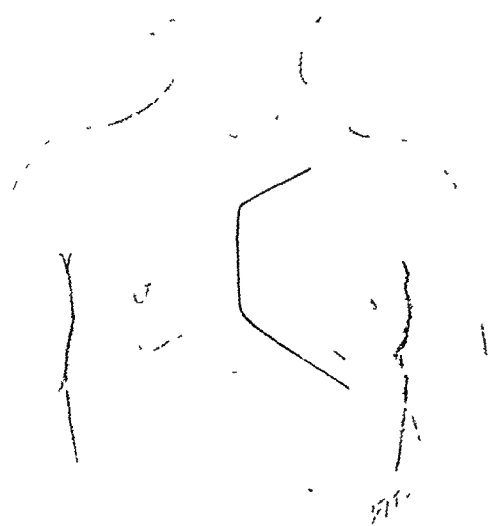


Fig 1 The skin incision used in the approach to the pericardium. A flap of the major pectoral muscle of equal size is reflected laterally with the skin flap.

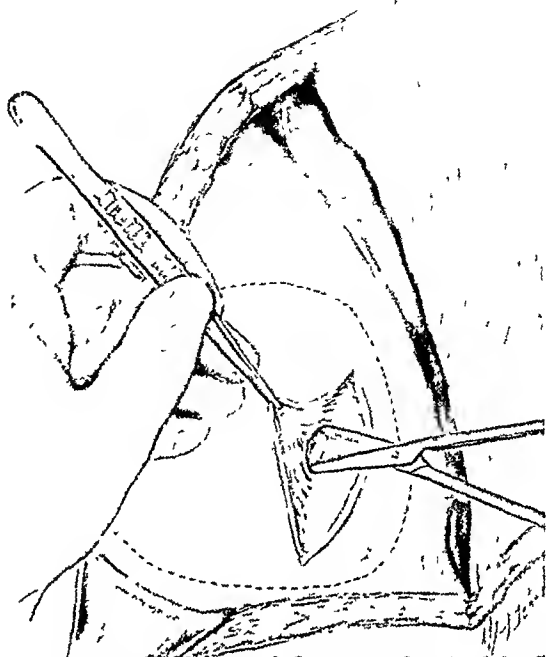


Fig 3 Pericardium exposed. An incision is made through it over left ventricle, a cleavage plane between it and cardiac muscle is established. Mobilization of pericardium is carried out with knife, scissors, or blunt dissection.

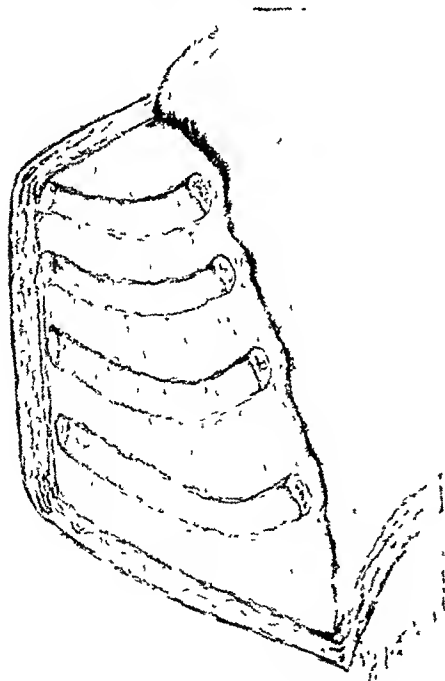


Fig 2 Skin-muscle flap reflected laterally. The second to fifth costal cartilages, inclusive, with adjacent segment of rib are resected subperichondrially and subperiosteally. An incision is carried through intercostal muscles which are reflected laterally as an additional flap.



Fig 4 The resection of the pericardium completed.

death appear in 12, of the latter, in 23. It does not appear from these data that anesthesia was responsible for the deaths. These findings together with our own experience indicate that anesthesia, excepting by those in desperate condition, is well tolerated by patients with constrictive pericarditis.

#### APPROACH TO AND EXPOSURE OF HEART

A greater part of the ventral surface of the heart may be exposed by an approach upon the left side of the thorax, and at the primary operation a skin muscle flap is reflected upon this side. The position and extent of the flap may be determined by the position of the heart with reference to the overlying costal cartilages and ribs as shown in the x-ray film. We have found it desirable to expose the heart from its base to its apex, and to do so it may be necessary to resect inclusively the second to the fifth, the third to the sixth, or the second to the sixth costal cartilages and segments of the adjoining ribs. The skin muscle flap is formed by incisions which overlie respectively the uppermost and lowermost costal cartilages to be resected and which are connected by a vertical incision corresponding with the midsternal line (Fig. 1). The major pectoral muscle is freed from the sternum and ribs and reflected laterally with the skin flap. The costal cartilages and segments of the corresponding ribs are resected (Fig. 2). Thus far we have done a subperichondrial and subperiosteal resection and have preserved the intercostal muscles, which are divided at the left sternal border and together with the posterior perichondrium and periosteum are reflected laterally as an additional flap. The dissection is then carried down to the pericardium along the left sternal border and the fat and connective tissue overlying it are carefully freed and stripped laterally, carrying with them the reflection of the left pleura. It is during the course of this maneuver that the left pleura may be torn and, therefore, it should be carried out slowly and carefully. The pericardium is freed to the left lateral border of the heart from the apex to the base in the course of which the left phrenic nerve may be brought into view. Having exposed the left pericardium, a similar procedure is

carried out over the right heart and to its right border. In doing so the heart is depressed so as to create a space between it and the sternum, sufficient to allow the subsequent resection of the pericardium. In 6 of the 7 patients subjected to pericardiectomy, it was possible to resect the pericardium over the right heart without resecting any portion of the sternum, in 1 case (Case 7) the resection of the left half of the sternum seemed necessary to obtain sufficient exposure.

A review of the literature shows that surgeons interested in the treatment of this disease are in agreement that the primary approach to the heart should be upon the left side, and that a right-sided approach should be reserved for cases in which at the primary operation the pericardium over the right ventricle cannot satisfactorily be mobilized. Schmieden and Churchill favor the complete resection of the bony thoracic wall over the heart rather than a subperiosteal and subperichondrial resection, believing it desirable that a mobile thoracic wall over the heart should be maintained. In our own cases, the ribs and costal cartilages have been reformed with the restoration of the normal thoracic wall, a condition which thus far in our experience has seemed consistent with satisfactory results. Churchill and others proceed at once to the resection of the left half of the sternum, finding that the additional trauma involved is compensated for by the greater ease in exposure of the right heart.

#### RESECTION OF THE PERICARDIUM

It has been our practice after fully exposing the pericardium, to incise it over the left ventricle and devote such time as may be necessary in establishing the most satisfactory cleavage plane between it and the heart muscle (Fig. 3). In some cases a satisfactory cleavage plane is at once evident and the mobilization of the pericardium may be proceeded with at once. Again there may appear to be complete fusion between pericardium and myocardium making the dissection of the pericardium a time-consuming matter. In some cases the pericardium is thickened and fibrous but not calcified; in other cases almost a complete bony shell, in still others a fibrous

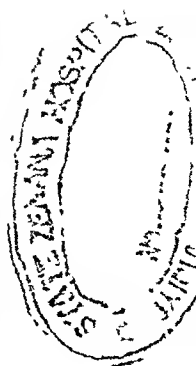
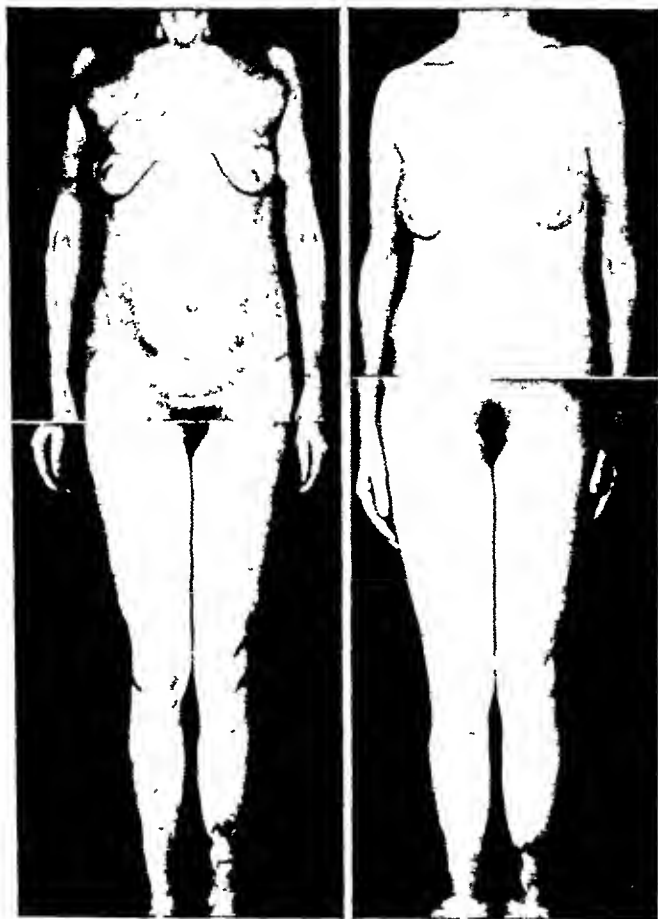


Fig 6 Case 1 Infra-red photographs showing the gradual disappearance of the venous congestion a, left, December 9, 1936, taken about 10 months after operation, b, November 30, 1937, taken about 22 months after operation. Improvement in this patient was slow but she is now "cured."

tion between pericardium and myocardium well ahead of the cut edge of the pericardium so as to maintain a flap of this structure which we could bring against, and suture to, the heart muscle if it was inadvertently torn. We have also at times abandoned the attempt to separate a plaque of calcification or a particularly adherent piece of pericardium from the heart, thinking it better to leave it as a patch on the muscle than to risk injury to the heart muscle in an attempt to remove it (Fig 4).

How much of the pericardium it is necessary to remove in order to achieve satisfactory results is a difficult question. We have removed

as completely as possible the pericardium over the left and right ventricles, but have not attempted to remove the adherent pericardium over the auricles. An effort has been made to free the apex, and if possible the dissection is carried well down on the diaphragmatic portion of the pericardium. No attempt has been made to go beyond the right auriculo-ventricular groove, nor have we attempted to free the great vessels at the base. Schmieden first removes the pericardium over the left ventricle and believes the primary removal of the pericardium over the right ventricle is dangerous, for the sudden release of the thin-



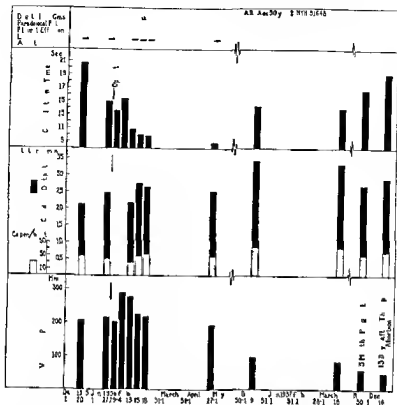


Fig. 5. Case 1. Studies of the circulation before and after operation. These include observations on the circulation time, cardiac output, and venous pressure. Certain clinical observations before and after operation also are noted.

membrane containing areas or plaques of calcification of various size and distribution. Calcified areas may be present over the right ventricle but not over the left may occur chiefly over the apex and diaphragmatic border of the heart or surround the great vessels at the base. They may be separated easily from the heart muscle or may extend into and involve the heart muscle. It is evident from these considerations that the resection of the pericardium may not be too difficult, or it may be extremely difficult and dangerous.

It has seemed best to us to dissect the pericardium off of the left ventricle first and for the reason that there is less likelihood of tearing into the left than the right ventricle in starting the mobilization of the pericardium. There is also less danger of overdistention of the left than the right heart. The mobilization is carried lateralward so as to free the

apex and left border of the heart, upward to the base of the heart, and downward to the diaphragm. A region where particular care is desirable is the interventricular groove containing the descending branch of the left coronary artery. It is here that adhesions between pericardium and myocardium may be particularly dense and it is possible as in one case in our experience that a part of the artery may be dissected out of its bed with the pericardium, the division of which might seriously interfere with the circulation of the heart. Having safely crossed the interventricular groove the mobilization of the pericardium is carried out over the right heart to the right, if possible to the right auriculoventricular groove, upward to the base of the heart and downward to the diaphragm. It has seemed easiest to resect the pericardium in fragments but we have always carried the line of separa-

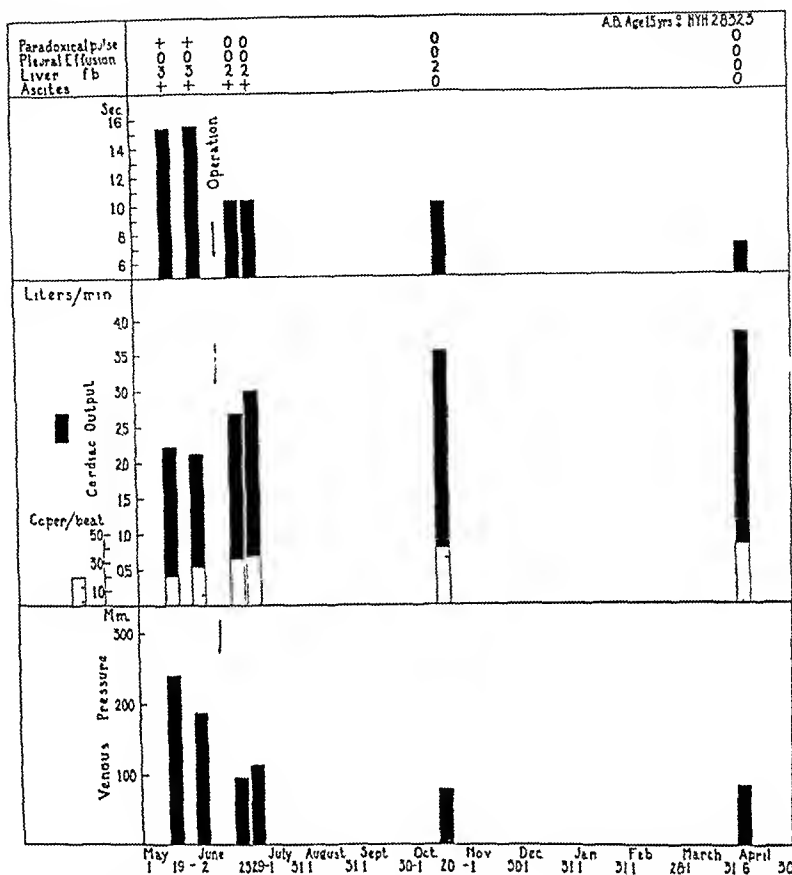


Fig 8 Case 2 Studies of the circulation and notation of the prominent physical signs before and after operation

the heart occurred not infrequently, and in the majority of cases the dilatation of the right ventricle and its herniation through the pericardial defect added to the difficulties of the procedure. The manipulations necessary in the mobilization and removal of the pericardium certainly play a rôle in the irregularity of cardiac action. All the circumstances tend to urge the operator to hurry and finish the operation—but it is a tendency to be resisted. It has seemed to us wise to pause periodically in the course of the operation in some cases, in order to allow the heart to regain a more normal rhythm.

That great care in the operative procedure is of importance in the success of the surgical treatment of chronic constrictive pericarditis is evident from a survey of the literature. A study of the records of 19 patients who died

upon the operating table shows that in 7 no data referable to death are given while in 12 some data appear which might suggest the cause of death. Of these 12 deaths, 4 were the result of injury to the auricle (1) or ventricle (3), in 3 it was the result of, or at least associated with, the overdilatation of the right ventricle, in 2 it was ascribed to "cardiac failure" and "ventricular fibrillation" and 1 was the result of pressure pneumothorax. The 2 remaining patients are described as "extremely weak and cyanosed" and in "critical condition" when subjected to operation. Of the 28 patients who died after operation, data regarding the cause of death are lacking in 5. Of the 23 cases in which some data are available, death was due to injury to the ventricle during operation in 2, to wound complications (infection, empyema)



Fig. 7 Case 1. Roentgenograms of chest before and after operation. a left January 27, 1936, taken the day before operation showing the cardiac shadow and pleural effusion. b December 16, 1937, taken 22 months after operation when described as "cured." The earlier x-ray pictures taken before operation are not reproduced because the pleural effusion obscured the cardiac outline.

walled right ventricle at a time when the left ventricle is still supported, may lead to its sudden dilatation and even rupture. He attributes a death on the operating table to such an overdistention. Churchill, Cutler, and Beck are in agreement with Schmieden. Burwell and Blalock, although admitting the theoretical possibilities, have failed to observe any harmful effects in cases in which the right ventricle was first subjected to decortication.

With regard to the extent of the decortication, Schmieden states that it is more important to consider what parts of the thickened pericardium should be allowed to remain to support the weakened heart than how much should be removed. Because of the danger of acute tricuspid insufficiency and to avoid a deficiency of the auriculoventricular valves leading to inflow venous congestion, Schmieden states that the decortication should not be carried beyond the coronary sulcus. He emphasizes also the liberation of the apex of the heart which may be firmly fixed to the diaphragm, a condition which prevents normal systolic contraction. If the apex cannot be liberated he advocates a left phrenicectomy. Churchill points out that the sulcus formed by the descending branch of the left coronary artery is apt to be the site of unusually dense adhesions and that great care should be ex-

ercised in this region to prevent injury to this important artery. He is of the opinion that the mobilization of the right auricular groove is an important step in the operation, indeed a "crucial" step in relieving obstruction to right ventricular filling. Several authors have referred to the importance of removing the scar about the vena cava, but Burwell and Blalock have made no attempt to remove it and have observed improvement in most of their cases.

Not only may the decortication of the heart be of itself a tedious and dangerous procedure but it is made more so because of the necessity of operating upon an organ in constant motion and one very sensitive to external stimuli. In the 7 patients subjected to operation the heart beat as counted at the wrist, varied between 100 and 160 and in all cases was over 130 during the greater period of the operation. In 2 cases the heart action was fairly regular, in 5 markedly irregular. In some cases there were periods of paroxysmal tachycardia, in others transient ventricular fibrillation, in still others such complete loss of rhythm that the cardiac action could be described only as complete arrhythmia. Periods of transient stoppage of

In the publication of page 1, line 10, the article by Beck had "effect upon cardiac action."

in 5, to acute cardiac failure (variously designated "acute failure," "myocardial weakness," "acute dilatation") within 48 hours of operation in 6, to late cardiac failure (18 days to 2 months) in 4; to tuberculosis in 2; and to a variety of causes ("angina," "cachexia," "exhaustion," "sudden no data") in 4. A summary of these findings shows that of 35 patients in whom data regarding death are available, 26 died upon the operating table or within 48 hours of operation, and of these 6 died as a result of injury to the heart during operation, 6 died of wound complications (infection, 5, pressure pneumothorax, 1), 11 died from acute cardiac failure, and 3 died without explanation other than that they were desperate surgical risks when subjected to operation. Almost one-half the deaths, then, were purely surgical and possibly avoidable, one-half were due to acute cardiac failure which immediately followed and well may have been the result of the surgical procedure. Whether some of these deaths might not have been averted by gentler manipulations at the time of operation is problematical.

#### CLOSURE

In the 7 patients whom we have subjected to operation, bleeding has been controlled as perfectly as possible and closure of the large wound has been with silk and without drainage. In 6 cases, healing of the wound has been *per primam*; in 1 case a hematoma developed in the lower part of the wound followed by a localized, superficial infection which did not jeopardize the wound as a whole. In this case there also developed a moderate sized left hemothorax complications the result of imperfect hemostasis. In the closure of the wound we have retained all the layers reflected, first resuturing the intercostal muscles and posterior perichondrium at the sternal border, then the major pectoral muscle, and finally the subcutaneous layer and skin. Schmieden not only resects completely the bony thoracic wall but excises the major pectoral muscle, using only the skin and subcutaneous tissue to cover the heart. Churchill resects the bony thoracic wall but retains the pectoral muscle. Both surgeons think a mobile thoracic wall over the decorticated



Fig 11 Case 2 October 20, 1936 Photograph taken about 5 months after operation showing the scar of operation

heart is desirable. Our experience thus far in cases followed over 2 years indicates that the reformation of a rigid thoracic wall is not incompatible with satisfactory results.

#### POSTOPERATIVE TREATMENT

Five of our 7 cases had a surprisingly smooth postoperative convalescence and neither an oxygen tent nor any special form of postoperative therapy seemed indicated. Two patients were somewhat cyanotic soon after their return to the ward and were placed in an oxygen tent for a few hours. One patient, as previously noted, developed a hemothorax for which aspiration was performed. The same patient developed a local superficial wound infection which closed up under appropriate treatment. Subsequent to the immediate postoperative period the diet and salt and fluid intake prescribed before operation were continued for a time, as were diuretics when indicated. Three patients were found not to require them, 4 were given weekly injections of mercupurin, and 1, urea, after they had been ambulatory. Churchill



Fig. 9. Case 2. Infra red photographs showing the striking change in the superficial venous bed following pericardiectomy. a May 20 1936 taken before operation b June 20 1936 taken 3 weeks after operation c April 6 1937 taken 10 months after operation. Note also the disappearance of the ascites and the remarkable growth of the girl which has taken place during this short period.



Fig. 10. Case 2. Roentgenograms of the chest taken before and after operation. a and b June 2 1936 taken before operation. The lateral view b shows the calcification of the pericardium. c April 6 1937.



Fig 13 Case 2 Roentgenograms of chest before and after operation. Comparison of b (September 22, 1938) taken 22 months after operation with a, left (November 11, 1936), taken before operation shows a decrease in the cardiac silhouette

was 4 months' pregnant, had a marked pallor and enlargement of the spleen. The cardiac rate was rapid but there were no signs of heart failure. Blood cultures taken on March 21 and again a week later were positive for *Streptococcus viridans* in small numbers. A roentgenogram of the chest failed to show evidence of pulmonary tuberculosis, the cardiac shadow was not remarkable except for a prominence along the left ventricular border. The urine contained albumin, red blood cells and a moderate number of granular and cellular casts.

Within 6 weeks of her admission certain changes in her physical condition had become manifest. There was increasing distention of the veins of the neck, the appearance of râles at the bases of both lungs, progressive enlargement of the liver, and soft pitting edema of the legs. The radial pulse had become paradoxical in quality. On May 12, 1935, the patient left the hospital against advice but returned in 2 weeks with cyanosis, swelling of the ankles, and weakness. Examination at this time showed dyspnea, cyanosis, distention of the veins of the neck and right pleural effusion. The heart was not remarkable, the pulse paradoxical. The liver was enlarged, the uterus corresponded with that of a 7 months' pregnancy, there was no ascites. The legs were edematous. At rest in bed the pulse remained rapid, the dyspnea and cyanosis persisted. She was digitalized rapidly over a period of 24 hours after which a maintenance dose was continued for 2 weeks. The drug had no effect either on the pulse rate or daily output of urine. On June 17, 1935, the patient went into labor spontaneously and after 8 hours was delivered of a living premature infant. The puerperium was uneventful.

On July 12, 1935, she again insisted on leaving the hospital. She remained in bed at home for 2 months, then got up and was moderately active. Her symptoms of dyspnea and weakness increased and a pro-

gressive enlargement of the abdomen occurred. She, therefore, reentered the hospital on December 3, 1935. On admission dyspnea, cyanosis, and orthopnea were noted, marked distention of the veins of the neck, signs of a large amount of fluid in the chest, moist râles over the bases of both lungs, marked ascites, marked enlargement of the liver and edema of the legs. The heart sounds were faint, the rhythm rapid and regular, the pulse markedly paradoxical. Special studies showed an increase in venous pressure, a diminished cardiac output, and a delayed circulation time (Fig 5).

The diagnosis of constrictive pericarditis in this case seemed positive, and operation was deemed advisable. The patient was given a diet containing 2 grams of salt, her fluid intake was restricted, ammonium chloride and mercupurin were administered. Abdominal paracentesis was performed on December 5, and 4000 cubic centimeters of fluid was withdrawn. Thoracentesis was performed on seven occasions and on each 1000 to 1300 cubic centimeters of fluid was withdrawn from the chest. The sediment from both abdominal and thoracic fluid was injected into guinea pigs with negative results for tuberculosis. As a result of all these measures the patient lost 14 kilograms in weight but later regained the weight.

Operation was performed on January 28, 1936, under ethylene anesthesia. A skin muscle flap was reflected upon the left side and the second, third, fourth, fifth, and sixth costal cartilages and the adjoining ribs were resected. The pericardium was exposed, was grayish white in color and appeared greatly thickened. When incised, the pericardium was found to be densely adherent to the heart but a line of cleavage was established. An area of pericardium 10 centimeters by 11.5 centimeters was removed. The excision extended to the left border of the left ventricle including the apex, to the right auriculoventricular sulcus, well up to the base of the



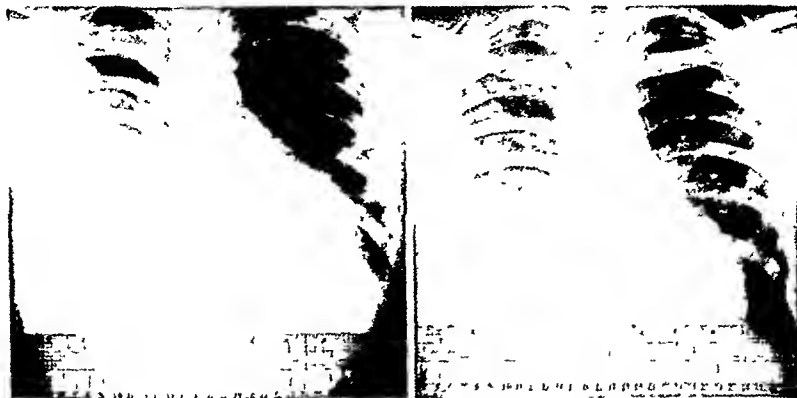


Fig 15 Case 4 Roentgenograms of chest Left, December 8, 1936, taken before operation. Right, January 29, 1938, taken 13 months after operation The shadow due to pleural effusion persists

the liver big and extending 8 centimeters below the right costal margin There was no edema of the legs The lungs appeared normal The heart did not appear enlarged, the sounds were distant but otherwise normal The rate was 126 per minute, the rhythm regular. The blood pressure was 88/52, the pulse definitely paradoxical Fluoroscopy showed a small heart with marked diminution in the amplitude of cardiac contractions. X-ray films showed calcification of the pericardium over the right and the lower part of the left ventricle Special studies of the circulation showed increased venous pressure, delayed circulation time, and diminished cardiac output A positive diagnosis of chronic constrictive pericarditis was made and operation advised (Figs 8, 9, and 10)

The pre-operative treatment consisted in complete rest in bed, a diet containing 2 grams of salt, restricted fluid intake, and the administration of mercuripurin and aminophyllin The drugs induced only slight diuresis and the result of pre-operative treatment was only slight decrease in the ascites Operation was performed June 5, 1936, under ether anesthesia A skin muscle flap was reflected over the left side and the second, third, fourth, and fifth costal cartilages and adjoining ribs were resected The pericardium was exposed and appeared greyish white and on palpation greatly thickened An incision was made through it and it was found that while the two layers of the pericardium were adherent, the adhesions were not particularly dense, a cleavage plane was therefore easily established and the mobilization and excision of the pericardium comparatively simple Because of the extensive calcification of the pericardium, heavy instruments were occasionally necessary The pericardium was removed over the left and right ventricles, an area 6 centimeters by 7 centimeters, as subsequently measured, being resected The heart herniated markedly, but its rate and rhythm remained satisfactory The wound was closed without drainage Gross and microscopic examination of the excised pericardium showed a struc-

ture 3 millimeters in thickness with extensive calcification but no evidence of tuberculosis

The postoperative course was remarkably smooth and uneventful Within a month after operation the venous distention had decreased markedly, the pulse had ceased to be paradoxical, the liver had decreased in size, and the ascites had almost disappeared The patient was discharged on the twenty-eighth post-operative day She returned from time to time for re-examination Her improvement continued, she developed physically in a remarkable way, and gained greatly in weight. At the present time (November 17, 1938) 2½ years after operation, she is a normal healthy girl leading an active life and able to engage in vigorous athletics Careful examination reveals no symptoms or signs of heart failure (Fig 11)

CASE 3 W M, History No 103699, a male aged 36 years, was first admitted to the New York Hospital July 26, 1935, complaining of dyspnea on exertion and swelling of the ankles of 12 months' duration With the exception of frequent colds and mild attacks of asthma his health had been good until 16 months before admission when he developed chills, fever and cough, productive of brown sputum He entered the Morrisania Hospital where a diagnosis of bronchopneumonia was made The report from this institution shows that he remained febrile for 2 months at the end of which time the temperature returned to normal There developed, however, a bilateral pleural effusion, ascites, generalized dependent edema, enlargement of the liver, and distention of the veins of the neck Except for a rapid rate the heart on examination was not remarkable The patient was discharged from the Morrisania Hospital July 6, 1934 He remained short of breath on exertion, his ankles were swollen, he had a constant ache in the epigastrium, a cough with yellow expectoration and continuous mild wheezing In the 12 months before admission to the New York Hospital, these symptoms increased and he developed orthopnea, precordial pain, and marked weakness



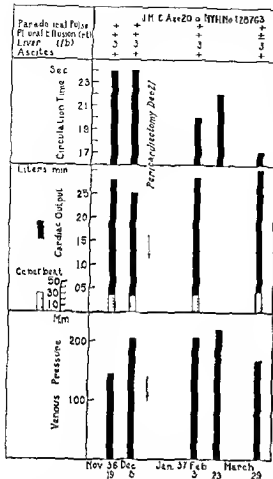


Fig. 14. Case 4. Studies of circulation before and after operation.

heart and down to the diaphragmatic pericardium. During the operation the heart herniated through its pericardial covering in rather an alarming fashion but the cardiac rate and rhythm remained satisfactory. The wound was closed without drainage. The patient withstood the operation well. The postoperative course was uneventful. The study of the pericardium removed showed it to be a dense fibrous structure from 3 to 4 millimeters in thickness. Microscopic sections of which revealed typical tubercles and giant cells indicative of a tuberculous infection.

The postoperative story of this patient is as follows. The physical signs of heart failure did not immediately change and during her postoperative period in the hospital she was treated with ammonium chloride, mercurium and theocain. She was discharged from the hospital a little over 2 months after operation with some but not striking evidence that

the condition was greatly changed. But gradually her condition improved 3 months after operation the signs of cardiac failure were greatly diminished and 5 months after operation had disappeared. Re-admission to the hospital for re-examination approximately 1 year after operation showed that all signs of her previous condition had disappeared. The paradoxical pulse was no longer present, venous pressure had returned to normal, venous engorgement had disappeared and circulation time was normal. She was leading her usual active life without symptoms. Fourteen months after operation the patient was discovered again to be pregnant and it was thought advisable to terminate the pregnancy. A therapeutic abortion under ether anesthesia was well tolerated. Eight months later the patient again was pregnant. She was readmitted, the uterus emptied and the fallopian tubes ligated to affect sterilization (Fig. 6 and 7).

At the present time November 17, 1938, 2 years and 10 months after operation, she is in excellent health, does all her own work, and leads an active life with no symptoms or signs of heart failure.

The case is an example of slow recovery after operation, and, as an apparent cure of tuberculous pericarditis, is unique.

**CASE 2. A. B. History No. 0323.** Female aged 15 years was admitted to the New York Hospital May 14, 1936, complaining of swelling of the abdomen for 5½ years. There was no history of exposure to tuberculosis. She had had a single attack of polyarthritides at 6 years of age but no other manifestations of rheumatic infection. There was no evidence of cardiac disease until at the age of 10 years her parents observed that she had become listless and her abdomen began to swell. The size of the abdomen increased and 4 months after the onset of symptoms she was taken to Bellevue Hospital where 3 abdominal taps were performed in 7 weeks, a large amount of fluid being obtained on each occasion. This treatment had no effect and some time later jaundice was present for a short period. About 6 months after the onset of symptoms the abdomen still being greatly distended she was taken to the Broad Street Hospital where an exploratory laparotomy was performed. The liver was found to be greatly enlarged and its surface studded with small excrescences like tubercles. A diagnosis of tuberculosis was made. The swelling of the abdomen persisted but the child attended school regularly for about 4 years. At the end of this period the swelling of the abdomen increased still more and there appeared dyspnea on exertion, weakness, anorexia and progressive emaciation.

On admission to the New York Hospital the girl appeared markedly emaciated and chronically ill. There was cyanosis of the lips, marked engorgement of the veins of the neck and increase in the size and number of the superficial veins over the entire body. The abdomen was greatly distended and full of fluid.

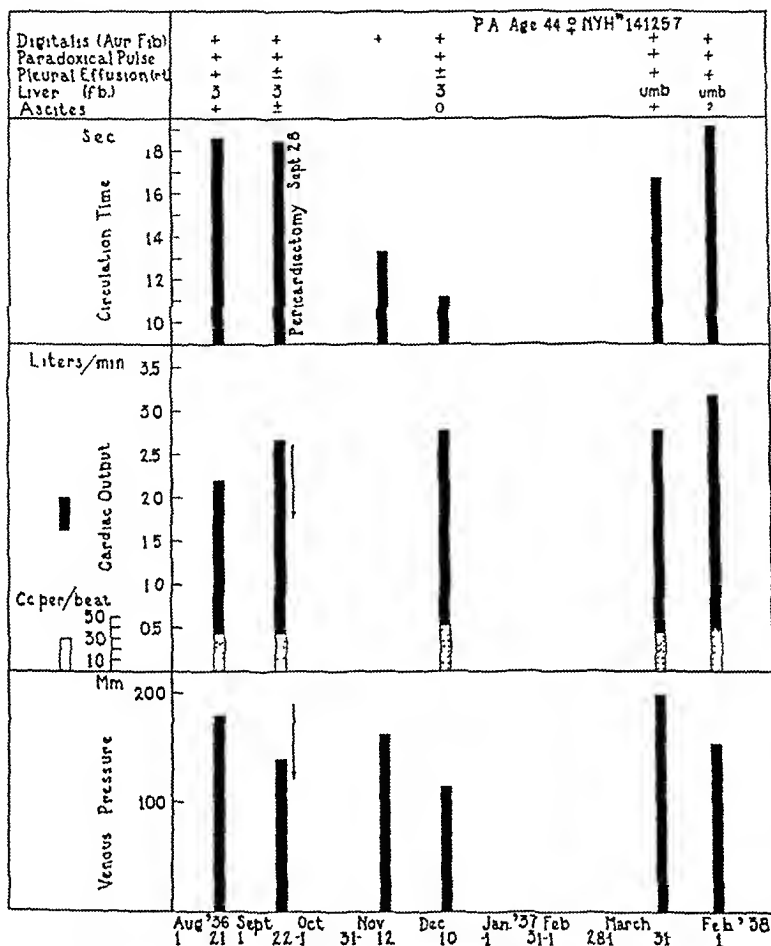


Fig 18 Case 6 Studies of circulation before and after operation

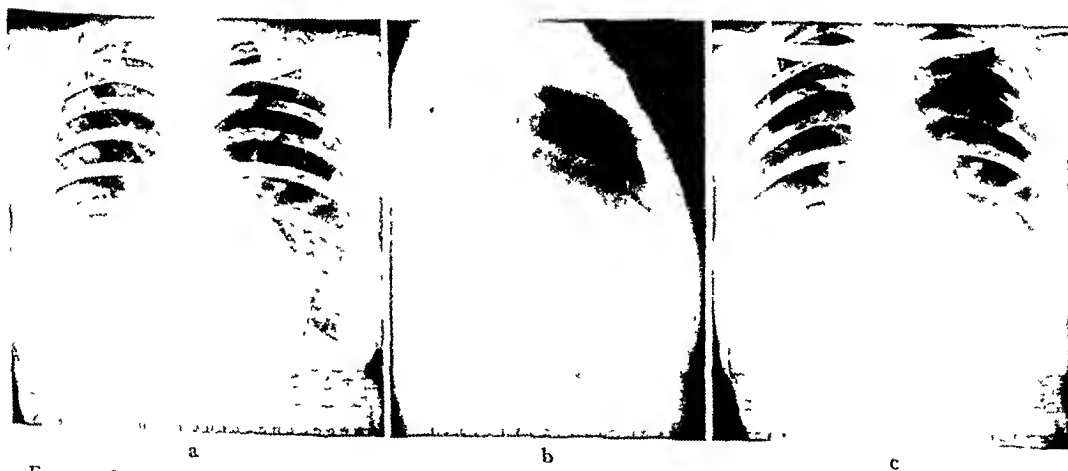


Fig 19 Case 6 Roentgenograms of chest before and after operation a and b, September 22, 1936, taken before operation show extensive calcification of the pericardium, c, December 10, 1936



Fig 16 Case 5 Infra red photographs taken before and after operation a May 26 1937 taken after medical treatment but before operation b November 19 1937 taken 4 months after operation c January 8 1938 taken 7 months after operation

Physical examination on July 26 1935 showed a man acutely ill with marked dyspnea cyanosis and orthopnea. The veins of the neck were markedly distended the pulse was paradoxical in quality the liver was enlarged the abdomen contained fluid and both legs were edematous. The heart was not remarkable the lungs showed moist râles over both bases and many sibilant wheezing sounds. The blood pressure was 122/90. During the first 24 hours in the hospital he was partly digitalized and perhaps as a consequence the distention of the veins of the

neck increased. A phlebotomy was performed with the removal of 650 cubic centimeters of blood a procedure which appeared to relieve his venous distention dyspnea and cyanosis. Both digitalis and phlebotomy were employed before the true nature of the condition was appreciated. Under rest in bed a low salt diet theocalfin and a maintenance dose of digitalis excellent diuresis was obtained. X-ray and fluo oscopy examinations of the heart July 30 1935 showed marked diminution in the amplitude of cardiac pulsations no evidence of valvular heart dis-



Fig 17 Case 5 Roentgenograms of chest before and after operation Left June 15 1937 right November 19 1937 taken 5 months after operation



Fig. 21 Case 7 April 19, 1938 Roentgenograms of the chest before operation. The anteroposterior view shows the unusual extension of the left ventricle to the left. See operative note. The lateral view shows the heavy calcification of the pericardium.

patient was given acetyl salicylic acid and coincidentally the temperature fell 1 to 2 degrees. Mercupurin and ammonium chloride were given without inducing diuresis, nevertheless, repeated fluoroscopic examinations showed a steady decrease in the pericardial and pleural effusions. Two months after admission these could no longer be demonstrated although the other signs of heart failure remained unchanged. The patient was discharged June 28, 1936. The dyspnea, swelling of the abdomen and ankles continued, and he was readmitted November 18, 1936. The fluid in his chest had reaccumulated, there was distention of the veins of the neck, enlargement of the liver and ascites. Roentgenograms of the heart showed some enlargement to the left and less enlargement to the right. Fluoroscopy of the heart showed only very slight pulsation. He was again discharged but readmitted December 7, 1936, for resection of pericardium. The usual pre-operative preparation resulted in some improvement and a loss of 2.5 kilograms in weight (Figs. 14 and 15).

Operation was performed December 21, 1936. A skin muscle flap was reflected upon the left side and the third, fourth, fifth, and sixth costal cartilages and adjacent ribs were resected. The pericardium appeared opaque and thickened. It was incised over the left ventricle and found to be so densely fused with the heart that a cleavage plane was established and continued only with the greatest difficulty. The mobilization and resection of the pericardium was a difficult undertaking. An area 6.5 by 8.5 centimeters was resected. The heart bulged through the pericardial defect. Frequently during the dissection the heart became irregular, stopped beating temporarily, or exhibited periods of paroxysmal tachycardia. The wound was closed without drainage. The resected pericardium was 2 to 3 millimeters in thickness and on section showed a fibrous connective tissue, containing foci of polymorphonuclear leucocytes and lymphocytes suggesting an acute inflammatory process.

The patient withstood the operation well. A few hours after operation an increase in cyanosis was noted and he was placed in an oxygen tent. The morning after operation his condition was good and he was removed from the oxygen tent. Thereafter his convalescence was uneventful. His improvement was gradual but continuous. In his postoperative course ammonium chloride and mercupurin were given periodically. The signs of heart failure diminished but did not completely disappear. He was discharged from the hospital March 3, about 6 weeks after operation. Since then he has been re-examined from time to time. He has been up and about, has attended college regularly, is capable of moderate exercise, feels well, and is free from cardiac symptoms. Certain signs of his previous condition persist, as slight distention of his veins, engorgement of the liver, and a small amount of ascites. At the present (December 2, 1938) he is continuing his work at college. There are no symptoms of heart failure. There are signs of a small amount of fluid at the base of the right lung, enlargement of the liver to 2 fingers' breadth below right costal margin and minimal pitting edema of ankles. There is no longer distention of the cervical veins, nor signs of ascites. Mercupurin has not been required for 5 months.

CASE 5 J. S., History No. 169168, a female aged 38 years, was admitted to the New York Hospital May 24, 1937, complaining of swelling of the legs of 6 years' duration. There was no history of tuberculosis or rheumatic fever. Her health had been good until 6 years before admission when she had a bout of fever, cough, and stabbing pain in the left scapular region. This illness confined her to bed for 3 months. She then resumed her usual activities but began to suffer from dyspnea on exertion, orthopnea and swelling of the abdomen and legs. She consulted a number of physicians who prescribed a variety of treatments including the administration of digitals, injections of mercupurin, and the operation of thyroidectomy, which was performed 5½ years prior to

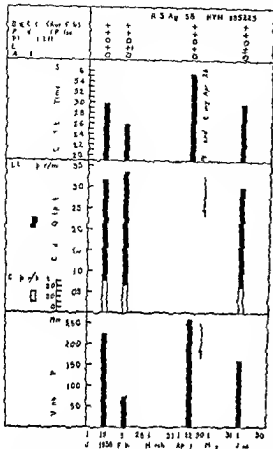


Fig. 20. Case 1. Studies of the circulation before and after operation.

ease and no pleural effusion. Under this medical treatment he improved and on October 30 was up and about ward. Discharged November 5, 1936, with the diagnosis of chronic constrictive pericarditis.

Following his discharge he returned to the cardiac clinic monthly for observation. He secured a position as night watchman and indulged in moderate exercise. Eleven months after discharge he noted again increasing dyspnea, swelling of the ankles and a troublesome fullness in the head on exertion. He was readmitted to the hospital November 9, 1936, and on examination showed moderate dyspnea, cyanosis and distention of the veins of the neck. The examination of the heart again failed to show anything remarkable. The pulse was paradoxical, the blood pressure 115/90. The liver was enlarged. There was no edema of the extremities. X-ray films and fluoroscopic examination showed slight enlargement of the heart, absence of motion of the right side of the heart but slight motion of the left ventricle. Operation again advised and he was put on our usual pre-operative treatment (Fig. 12 and 13).

Operation was performed November 25, 1936, under ether anesthesia. A skin muscle flap was reflected upon the left side and the second, third, fourth, and fifth costal cartilages and adjacent ribs were resected. The pericardium appeared thickened and no cardiac pulsations were visible even with the pericardium exposed. An incision was made through the pericardium over the left ventricle and a cleavage plane was established. Without untoward event an area of pericardium 8 by 10 centimeters was resected. The wound was closed without drainage. The pericardium resected was 2 to 3 millimeters in thickness and had the consistency of cartilage. Microscopic examination showed a fibrous tissue which in many areas had undergone calcification. No tubercle or other characteristic findings were present.

The postoperative course was uneventful. On the day after operation the veins of the neck were definitely less distended and within a week the venous engorgement had almost disappeared. Fluoroscopic examination of the heart 3 weeks after operation showed good pulsation where previously it had been absent. Improvement in his condition was progressive and on December 30, 1936, 5 weeks after operation he was discharged. He was readmitted for examination March 31, 1937, and it was found that all symptoms previously noted practically had disappeared. Seen on January 11, 1938, he stated he felt as well as he ever had in his lifetime even though he was working hard every day and not restricting his activities. At present (November 1, 1938) 2 years after operation he seems to be entirely well, is doing heavy physical labor daily and is without any symptoms or signs of cardiac failure.

CASE 2. J. McC. History No. 2363, a male aged 20 years was admitted to the New York Hospital April 20, 1936, complaining of weakness of 1 week's duration. He had never had rheumatism or chorea. His health had been excellent until 7 months prior to admission when he had fever and pain in the chest and was told after x-ray examination that he had pericardial effusion. He was in bed 3 months, then went about and felt well until 7 weeks before admission when he began to suffer from dyspnea on exertion, orthopnea and swelling of the ankles. These symptoms persisted and 3 weeks before admission fever and pain in the lower posterior portion of his right chest recurred. He developed a non-productive cough and pain in his left shoulder.

On admission the patient appeared acutely ill and febrile. There was slight dyspnea and cyanosis. Examination of the heart and lungs suggested a large pericardial effusion and right pleural effusion. The heart was regular and there were no thrills or murmurs. The blood pressure was 106/60. The radial pulse was paradoxical in quality. The liver was enlarged, the abdominal cavity contained fluid. There was no edema of the legs. The red cells numbered 6.7 million, the white cells 11,200. Fluoroscopic examination showed a large pericardial and right pleural effusion. The temperature rose daily to 39 or 40 degrees C. On the eighth day of admission the

of the previous signs and symptoms. She was admitted to the hospital October 8, 1937. Under appropriate treatment her signs again improved and she was discharged on December 5, 1937. Since then she has been followed in the cardiac clinic of the out patient department. At the present time (November 4, 1938), 1 year and 4 months after operation, she is quite able to do her own work. Her symptoms are slight dyspnea and moderate fatigability. Her signs of heart failure are very slight venous distention, enlargement of the liver to four fingers' breadth below the right costal margin, and moderate edema of the ankles. The radial pulse still is paradoxical.

CASE 6 P. A., History No. 141257, a female aged 44 years, was admitted to the New York Hospital on August 12, 1936, complaining of swelling of the ankles and abdomen. She had never to her knowledge had tuberculosis. At the age of 20 years she had fever and cough for a week, diagnosed as pneumonia by the family physician. At the age of 30 she suffered from acute polyarthritis but never had a recurrence of the condition. She was in bed for 2 months but it is not known whether there was any cardiac involvement at this time. At the age of 34 years, 10 years before admission, she first observed swelling of the ankles. There were no other cardiac signs until 10 years later when 2 months before admission she observed progressive swelling of the abdomen and slight dyspnea on exertion. About 2 months before admission she began taking digitalis each day and continued to do so to the day of admission.

Examination showed a well developed woman with dyspnea and cyanosis. The veins of the neck were engorged, the abdomen distended with fluid, the liver enlarged, the legs and ankles markedly edematous. There were signs of a moderate amount of fluid at the base of the right lung. The heart appeared moderately enlarged to the left, the cardiac sounds were distant and poor in quality but no murmurs were heard. The blood pressure was 110/70. The pulse was definitely paradoxical. The electrocardiogram showed auricular fibrillation, roentgenograms of the heart showed it to be globular in shape and slightly enlarged. There was extensive calcification of the pericardium. The fluoroscopy of the heart showed marked diminution in cardiac motion. X-ray films confirmed presence of fluid in right pleural cavity.

Treatment consisting of bed rest, a low salt free diet, restricted fluids, digitalis, ammonium chloride, mercupurin and theocalcin, led to excellent diuresis and general improvement. She lost 14.7 kilograms in weight (Figs 18 and 19).

Operation was performed September 28, 1936, under ether anesthesia. A skin muscle flap was reflected on the left side and the second, third, fourth, and fifth costal cartilages and adjacent ribs were resected. The pericardium was opaque and showed extensive calcification. It was incised over the left ventricle and found to be adherent to the underlying myocardium. A cleavage plane, however, was established and the pericardium over the left and right ventricles mobilized and resected. The pericardium

was especially adherent along the sulcus between the left and right ventricles but was finally freed without misfortune. The wound was closed without drainage. The pericardium, which was removed, measured from 5 to 8 millimeters in thickness. It consisted largely of a hard bone-like tissue. On microscopic section it was found to be dense cellular tissue with masses of calcification. There was a marked tendency to true bone formation with the development of bony trabeculae.

The patient withstood the operation well and her condition continued excellent until the day after operation when she showed dyspnea, cyanosis, and on physical examination a moderate pneumothorax was found. She was placed in an oxygen tent; the treatment was effective and her temperature, pulse, dyspnea, and cyanosis were improved. Her further convalescence was uneventful. In her postoperative course, ammonium chloride and mercupurin were administered periodically. On discharge from the hospital December 19, 1936, the signs of heart failure were less evident but still present. Since discharge she has been followed in the cardiac clinic. Improvement has been slow but definite. At the present time (December 2, 1938), 2 1/6 years after operation, she does her own work. Her only complaint is occasional slight dyspnea. Her physical signs are a moderate amount of fluid at the base of the right lung, enlargement of the liver to 4 fingers' breadth below the right costal margin, questionable ascites, and moderate edema of ankles. Radial pulse still is paradoxical.

CASE 7 R. S., History No. 185223, a male aged 58 years, was admitted to the New York Hospital on January 17, 1938. He stated that his health had been good until 6 years before admission, and that he had passed an examination for life insurance 9 years before admission. Six years before admission he began to note dyspnea on exertion and swelling of the ankles. On examination in a cardiac clinic he was thought to be suffering from "hypertensive heart disease with heart failure." X-ray of the heart showed "marked dilatation of the left ventricle," and electrocardiogram revealed "low voltage of QRS in all leads, T<sub>3</sub> inverted, T<sub>2</sub> partly inverted." He was given digitalis but his symptoms did not improve. In the 6 years that ensued he visited a number of private physicians who treated him with digitalis and injections of mercurial diuretics but his symptoms persisted, and 3 years before admission to the New York Hospital dyspnea became so marked that he was forced to stop his work as a tinsmith. In the 2 month period immediately preceding admission he had been taking digitalis regularly and had been receiving an intravenous injection of mercupurin once a week in an attempt to control the swelling of the ankles. On admission to the New York Hospital January 17, 1938, there was slight cyanosis but no dyspnea or orthopnea. The veins of the neck were moderately distended when he sat erect. There were a few moist rales at the bases of both lungs, posteriorly. The heart showed enlargement to the left on percussion, and the rhythm appeared to be totally

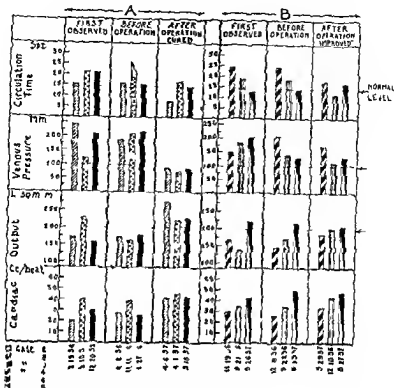


Fig. 22. Summary of the circulation studies in the first 6 cases subjected to pericardectomy. Three cases in group A are cured; 2 cases in group B are improved.

admission. In spite of treatment her symptoms increased in severity and she entered the hospital.

Physical examination on admission showed a moderate dyspnea, orthopnea, and cyanosis. The veins of the neck were distended. The liver was enlarged, the abdomen contained a moderate amount of fluid, the legs exhibited a massive edema extending well up on the thighs. The lungs showed moist râles at both bases. The heart sound were faintly well heard; there were no murmurs and the rhythm was regular. The radial pulse was markedly paradoxical. The blood pressure was 130/78. Fluoroscopic copy of the heart showed only faint pulsation of the right ventricle and only slight pulsation of the left ventricle. The heart was slightly enlarged. Roentgenograms failed to show calcification of the pericardium. Under complete rest in bed a diet consisting of 2 grams salt restriction of fluid, ammonium chloride, and injections of mercupurin, there was some improvement. Thoracentesis was then administered which increased the urinary output moderately. Three weeks after admission the dyspnea, cyanosis, and orthopnea were no longer evident. The liver decreased in size, the ascites had diminished, and the edema of the legs was less evident. She had lost 13.4 kilograms in weight (Figs. 16 and 17).

Operation was performed June 27, 1937, under ether anesthesia. A skin muscle flap was reflected on the left side and the second, third, fourth, and fifth costal cartilages and adjacent rib ends were resected. The pericardium on exposure appeared opaque, hard, and thickened. It was incised over the left ventricle and found to be only loosely adherent to the heart. A cleavage plane was easily established and the mobilization and resection of the pericardium proceeded without difficulty. A large area of the pericardium was resected, the amount measuring 10.5 by 6 centimeters in diameter. The wound was closed without drainage. The pericardium removed was 3 millimeters in thickness, appeared fibrous and leathery, and on microscopic examination consisted of dense fibrous tissue with many foci of calcification. There were no tubercles or other significant findings.

The postoperative course was uneventful. At the end of 2 weeks the distention of the veins of the neck had diminished. Ammonium chloride and injections of mercupurin were used in the postoperative period and produced excellent diuresis, which before operation they had failed to do. The patient was discharged 2 months after operation. Seen from time to time in the cardiac clinic, it became evident that under moderate activity there was a reappearance

after the primary operation, he stated that he felt better than at any time since coming under our observation. His symptoms are minimal and consist of slight dyspnea. His physical signs are slight cyanosis, increased venous pressure, enlargement of the liver to 4 fingers' breadth below right costal margin, questionable signs of a small amount of ascites and moderate edema of the extremities. An evaluation of the results of operation is not yet possible.

#### SURVEY OF THE LITERATURE

We have found in the literature reports of 143 patients in whom the pericardium has been resected for chronic constrictive pericarditis. Of the 143 patients, 50, or 36.6 per cent, are reported as cured and 25, or 17.4 per cent as improved. Forty-seven, or 32.8 per cent of the patients died either upon the operating table (19) or in the immediate post-operative period (28). In addition to the 47 patients who died as a direct result of the operation, 13 are listed as having died at variable times after discharge from the hospital. An analysis of this group shows that 6 of the 13 patients lived more than 1 year, Schmieden's 2 cases lived 3 to 6 years, respectively; Beck's patient lived 6 years, L. Rehn's patient lived 1 year, and Lilienthal's patient lived "several" years. It is probable that these patients were improved, and they are so listed in our summary. Seven of the 13 patients died from 2 to 8 months after operation and presumably as a result of the continuation of the disease. Data regarding the results of surgical treatment are lacking in the reports of 8 patients. The final analysis, then, shows that of 135 patients in the reports of whom data are available, 50, or 37 per cent, are cured, 31, or 23 per cent, improved, and 54, or 40 per cent, died, either during or soon after operation.

The permanency of the cures reported in the literature has been questioned particularly by Paessler. The immediate effects of operation may be striking and dramatic, in a few months a water-logged, bedridden patient may be transformed into an individual capable of engaging in vigorous athletics. In other cases this return to normal is more gradual and may occupy a year. The information in the literature regarding the per-

manency of these favorable results often is lacking but certain data suggest that the results may continue over a period of years. Of Schmieden's 6 reported cures, 4 are well after 10, 12, 17, and 18 years; and of Churchill's reported cures 6 are well after 2 to 9 years, of which 5 are well more than 3 years. Five additional authors report patients well after from 5 to 11 years; 6 report cures of more than 2 years.

Paessler, however, after an investigation of 71 cases, is of the opinion that the late results have not been as favorable as the immediate results seemed to promise. He states that his studies have shown that the improvement after pericardiectomy has, in an appreciable number of cases, been followed after years by ill health with new and different manifestations which, however, cannot be interpreted as a recurrence of the constrictive pericarditis. He suggests that the chronic constrictive pericarditis is but one manifestation of a general disease process, the relief of which by decortication of the heart may not be sufficient to cure the patient; that it is necessary in addition to search for every possible focus of infection which, if found, is to be eradicated as a part of the treatment.

At first glance this record of surgical results may not appear to be impressive. But in judging the results it should be appreciated that the disease is incapacitating and invariably fatal, and to have improved or cured 60 per cent of the cases subjected to surgery is, after all, a real achievement. It should be realized also that the 150 cases represent the sum of the experience of 49 observers, 27 of whom have operated upon only a single case, 7 of whom have operated upon 2 cases, and 6 upon 3 cases. Only 8 surgeons, so far as can be determined from the literature, have operated upon 5 or more cases. It would appear certain that with more accurate diagnosis, a better selection of cases, more attention to pre-operative and postoperative management and greater perfection and experience in the operative technique, the results of this surgical treatment of chronic constrictive pericarditis will improve.



irregular. There were no thrills or murmurs. The blood pressure measured 135/100. The radial pulse was paradoxical in quality. The edge of the liver was felt 5 fingers breadth below the right costal margin in the midclavicular line. There were signs of a small amount of fluid in the peritoneal cavity. Both lower legs exhibited slight pitting edema. The hemoglobin amounted to 114 per cent. The count of the red blood cells was 5.4 million and that of the white blood cells 10,000. The blood Wassermann was negative. The total serum protein was 7.1 milligrams per cent. An electrocardiogram confirmed the diagnosis of auricular fibrillation. Roentgenograms of the heart showed the pericardium to contain extensive deposits of calcium, more marked on the right side of the heart than on the left. Both the right and the left ventricles were observed to be enlarged. Fluoroscopy of the heart showed fairly good pulsations in the region of the left ventricle and slight diminution of the pulsations on the right side of the heart. The patient was placed at bed rest. A diet low in salt was given, fluids were restricted to 1200 cubic centimeters daily and digitalis, mercupurin and ammonium chloride were used. These drugs were only moderately effective in producing diuresis during the first 4 weeks in the hospital but during the latter part of the patient's stay marked diuresis was observed in response to mercupurin. On February 5, 1938, the weight had decreased from 80.0 to 74.6 kilograms. The only signs of heart failure on this date were slight cyanosis and enlargement of the liver to 4 fingers breadth below the right costal margin. The radial pulse still was paradoxical in quality. The patient remained in the hospital for 7 weeks longer. There was no further change in the signs of the heart failure and the weight did not change appreciably. He was discharged on February 7, 1938. Following discharge the patient indulged in only slight physical exertion. He returned to the cardiac clinic once each week and was given injections of mercupurin 3.0 cubic centimeters intravenously. He restricted his intake of salt and fluid. In spite of these measures he again began to suffer from dyspnea on slight exertion and swelling of the lower legs. The patient was readmitted to the hospital on April 15, 1938, and operation was performed April 26, 1938 (Figs. 20 and 21).

Under intratracheal ether anesthesia a skin muscle flap was reflected laterally upon the left side so as to expose inclusively the second to sixth costal cartilages and ribs. The third, fourth, fifth and sixth costal cartilages together with segment of the corresponding ribs were resected subperiosteally and a second flap of tissue consisting of the intercostal muscles was reflected laterally. The extrapericardial fat and connective tissue were stripped from the pericardium together with the reflection of the left pleura. It was found in this case that the right heart could not be satisfactorily exposed and therefore the left half of the sternum immediately was resected. It was found after the pericardium was exposed that a cuff or cone of dense calcified tissue

surrounded the great vessels at the base of the heart that this cuff or cone was continuous with an area of calcification which covered the right heart but that the pericardium over the left ventricle was singularly free of calcification.

An incision was made through the thickened pericardium over the left ventricle and a cleavage plane between it and the heart muscle was established. Without great difficulty the left ventricle was uncovered well to the lateral border of the heart and the apex was completely freed. The separation of the pericardium from the right ventricle however was very difficult for here it was not only calcified but densely adherent to the wall of the ventricle. Nevertheless the right ventricle down to the diaphragmatic reflection of the pericardium was well exposed as it was as far to the right as the auriculo-ventricular groove. At the base of the heart however the calcified shell surrounding the heart and great vessels was so adherent that their exposure was not as satisfactory as in any of the 6 other cases. Throughout the operation moreover the heart was most sensitive to manipulations and was thrown into complete arrhythmia repeatedly. Application to the heart of novocain as suggested by Beck seemed to have no effect in improving the situation. Altogether the operation was most trying and from the viewpoint of freeing the base of the heart the most unsatisfactory of the 7 cases we have subjected to operation. The operative wound was closed in layers without drainage. The patient left the operating table in good condition.

The portion of the pericardium removed consisted of 2 pieces, one 7 by 4 centimeters the other 4 by 3 centimeters in size. In places it was but 1 millimeter in thickness in other places 4 millimeters in thickness. That over the right ventricle is largely calcified the calcium deposit resembling thin bony plates as in an infant's skull. Microscopic sections failed to show any evidence of tuberculosis.

The postoperative course was entirely satisfactory for 3 days. Then he complained of some dyspnea at night. Eight days after operation the operative wound appeared puffy and there was dullness at the left base. A needle was inserted under the flap and 60 cubic centimeters of old blood was drawn. The left chest was aspirated and 52 cubic centimeters of bloody fluid obtained. He was placed in an oxygen tent for short periods for the next 2 days. He continued to take daily doses of digitalis and to receive injection of mercupurin. He was discharged from the hospital July 9, 1938.

The patient was readmitted September 19, 1938, for a revision of his wound which still continued to drain. The sinus tracts were excised. The upper sinus extended from the midline rather deeply to the left and contained a quantity of granulation tissue which was removed. Under the Carrel-Dakin treatment the wounds rapidly granulated and at the time of discharge October 26, 1938, were quite small. He continues to return to the clinic. On the last visit November 17, 1938, 7 months

years. The longest duration was 15 years and the shortest 1 month. Four cases originated in warts, 3 on scars from previous burns which occurred 24 and 35 years before. Three gave a history of itching followed by ulceration and 5 a history of trauma. The others gave the origin from "sores," "pimples," or "growths." The treatment previous to admission varied from salves, repeated cutting with scissors, to "sprinklings of ground glass over the wound, and smoke of rooster's feathers." The blood Wassermann was negative in all cases. Eighty-five per cent of the patients were not engaged in any industry, being "too old to work." Thirty-one patients were white, 1 was a negress.

Volkman's observation in 1889 that epithelioma of the extremities is invariably of the squamous cell type still holds true. Only 3 cases of the basal cell type were found at the Brooklyn Cancer Institute during the past 10 years. These have been excluded.

Clinically, squamous cell carcinoma of the extremities appears in two forms: the ulcerative type characterized by indurated, irregular, rolled edges and necrotic base, and the cauliflower or solid form characterized by a fungating granulatous or papillary appearance. The ulcerative type, although the less malignant, has great destructive properties. The indurated rolled edges become necrotic and break down, while the adjacent skin becomes infiltrated and assumes the characteristics of the former edge, thus spreading along the surface of the extremity. The purulent secretion causes further destruction by undermining the edges of the ulcer and extending downward, penetrating the subjacent tissue, attacking the periosteum, and finally resulting in necrosis and destruction of the underlying bone (Cases 22 and 25). The tumor then grows downward between the spicules of bone, where it meets no resistance (Fig 1), or finds its way between the fragments of a pathological fracture. Although we may find carcinoma in the partially destroyed bone underlying the tumor, the carcinoma is part of the primary tumor and not of the bone. Even histologically proved cancer cells in sections of destroyed bone do not alter these findings. A similar case is illustrated by Kaufman in a man of 86 with an extensive carcinoma of the



Fig 1 Case 25. A above, Longitudinal section of amputated extremity showing A, anterior cortex, B, medullary cavity, C, posterior cortex, D, primary lesion of squamous cell carcinoma, E (arrow pointing), extension of carcinoma through the destroyed cortex into the medullary cavity, F, invasion of medullary cavity by bony trabeculae and hyalinized fibrous tissue, X, cross section removed for histological examination B, Photomicrograph of cross section X' showing D' primary malignancy. The anterior cortex is completely destroyed and replaced by hyalinized fibrous tissue, F', considerable invasion of the marrow cavity by cellular fibrous tissue, with destruction and absorption of the bony trabeculae, B', some fatty marrow, C', posterior cortex intact. C, Photomicrograph showing squamous cell carcinoma at D and D'  $\times 170$ .

leg and a pathological fracture of the tibia and fibula with carcinoma between fragments.

The opinion that bone destruction is due largely to the admission of bacterial infection rather than to neoplastic invasion is shared by Willis. He states that in the majority of closed non-infected tumors which have enveloped and adhered to contiguous bones or car-

# SQUAMOUS CELL CARCINOMA OF THE EXTREMITIES

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THE occurrence of squamous cell carcinoma of the extremities is comparatively rare. It comprises not more than 1 per cent of all the carcinoma in different parts of the body. (4) Volkmann was the first to call attention to this subject in 1889 when he analyzed 239 cases of carcinoma of the extremities. Thirty nine of these were from his own clinic during a period of 20 years. Heiman, in 1898, studied 20 544 cases of carcinoma and found only 207, or 1 per cent that affected the extremities. Broders found 44 cases in 2 000 admissions of general epithelioma, or 2 per cent, at The Mayo Clinic during the period of 1904 to 1915. De Asis, in 1926, found 17 cases of epithelioma of the extremities among 6,766 patients with carcinoma or 3 per cent, that were admitted to the Barnes Hospital and the Barnard Skin and Cancer Hospital of St Louis. At St Luke's Hospital in New York in 31 years only 9 cases were admitted to the wards and 6 to the dispensary, and at the New York Skin and Cancer Hospital only 26 cases were found among 35,000 admissions (12). From January 1923 to January 1934 at the Stuyvesant Square Hospital only 60 patients with squamous cell epithelioma of the extremities were admitted (5).

In the radiation therapy department of Bellevue Hospital New York, only 2 cases of squamous cell carcinoma of the fingers were found among 11,400 admissions. One case was reported by Rubinfeld in 1932, and the other by Siegel in 1937. Siegel found only 22 cases reported in the literature up to that time. At the Brooklyn Cancer Institute from 1928 to 1938 only 32 cases of squamous cell carcinoma of the extremities were found among 10,000 cases of carcinoma, or 3 per cent.

Von Brunn as well as other writers accept Volkmann's classification of carcinoma of the extremities (a) those that develop on chronic inflammatory tissue such as ulcers, scars,

fistulas, etc., (b) those that develop upon warts, moles, congenital or acquired, (c) those that develop on previously normal skin. In von Brunn's series of 320 cases, 227 occurred in the first group, 46 in the second, and 48 in the third. To bring Volkmann's classification up to date trauma should be added as a fourth group. Johnson stated that, "Epithelioma of the skin is induced almost exclusively by the chronic injury of previously normal or abnormal tissue." He reported 4 cases of carcinoma that originated on scar tissue following burns. He quoted Durand who reported 60 cases of degenerated scars 70 of which were caused by old burns. In our own series, 3 cases occurred on old burn scars and 5 followed direct trauma. Fox described a case of epithelioma of the hand following the bite of a horse. He quoted a similar case of von Winnwart and another case of Wurz of carcinoma of the forearm following the bite of a pig. Volkmann quoted a case that developed on the scar of a dog bite.

The age incidence of carcinoma of the extremities is higher than in any other malignancy. Males predominate over females in a ratio of 4 to 1. In our series of 32 cases the average age was 63, the oldest 86 and the youngest 33. Twenty occurred in males and 12 in females. The distribution of the lesion in order of frequency was dorsum of hand and wrist, leg, arm, forearm, foot, fingers, and thigh. The toes and the palmar surface of the hand are very rarely affected. The upper extremities are more often affected than the lower extremities. In our series 10 or 39 per cent occurred in the upper extremities arm 5, forearm 2, dorsum of hand 9, finger, 3, and 13 or 41 per cent occurred in the lower extremities foot, 4, leg, 7, thigh 2. Cases 5, 10, and 15 had multiple squamous cell carcinoma in other parts of the body. The average size of the lesion was  $4\frac{1}{2}$  centimeters. The largest involved two thirds of the leg and the smallest was 2 centimeters. The duration of the disease before admission averaged  $2\frac{1}{2}$

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Among 334 cases of skeletal metastases from all types of malignancy reported by Geschickter 5 per cent metastasized from the skin. In Broders' series of 32 cases of metastatic squamous cell carcinoma, 1 metastasized to the upper and lower ends of the humerus, 1 to the rib, and 1 to the chest wall. In our series Case 1 had a tumor the size of an orange in the axilla with metastatic carcinoma in the corresponding lung. In our Case 29 autopsy revealed metastases to both lungs, heart, liver, spleen, kidneys, and pancreas (Fig 2). On roentgenographic examination Case 23 in our series showed metastasis to the third lumbar vertebra. No other primary lesion except the leg could be found. Case 4 had roentgenographic evidence of metastases to the pelvis and upper third of both femurs, but the patient died at home. This patient had an enlarged prostate, which, however, was not proved malignant.

Treatment of squamous cell carcinoma of the extremities is mainly surgical. Of 256 cases of squamous cell carcinoma of the skin at The Mayo Clinic reported by Broders, 236 or 92 per cent were treated surgically. DeBell and Stevenson, at Stuyvesant Square Hospital, state that all squamous cell carcinoma of the skin are treated by surgery in that institution. They believe that this method of cancer therapy is particularly adaptable to lesions on extremities. Perez, of the New York Skin and Cancer Hospital, in reporting 26 cases of epithelioma of the extremities concludes that adequate surgical removal is the treatment of choice. He states that radiation, either by radium or roentgen therapy, is not satisfactory. Johnson, of the Radium Department of the Steiner Clinic, reports that the treatment with radium therapy of a tumor with a scar tissue foundation is unwarranted, and that curative treatment is strictly surgical. Adair, at Memorial Hospital, New York, states that amputation of the hand for epithelioma should not be a very common procedure. He believes that, "If the ulcerating epithelioma is still confined to the integument, the best treatment is the application of radium plaques, 1 or 2 applications of 1000 millicurie hours each." If the lesion has infiltrated the tissues deeper than the integument, irradiation of whatever type

used is not effective. He concludes that if the lesion is large, deep, and painful, it often becomes necessary to amputate the hand.

In our own series of 32 cases, 16 received roentgen therapy alone, 7, x-ray therapy plus surgery, 6, surgery alone; 3, radium and surgery. Nine patients died, the youngest was 52 years, the oldest 82 years, the average age was 66 years. Four died from bronchopneumonia, 2 from cardiovalvular disease, 2 following amputation above the knee (24 hours and 1 week after operation), and 1 died from general metastases. Six patients could not be traced. When they were last seen they had no recurrence and were well for an average of 16.5 months following treatment. The average duration of cure in the 12 other patients was 2 years. The longest duration of cure was 8 years and 5 months. These patients are still being followed in our clinic.

One must agree with Adair that radiation has its use in the treatment of squamous cell carcinoma of the extremities, it also has its limitations. The ulcerative type, particularly, as pointed out by Adair, is too infected for conservative surgery, and one surely does not amputate for superficial ulcerated carcinoma. On the other hand, in the non-suppurative type there seems to be no logic in doing incomplete surgery for an adequate biopsy and not excising the whole lesion for curative purposes.

The deep-seated carcinoma and also the superficial ulcerating carcinoma that does not respond to radiation are exclusively surgical and amputation is the treatment of choice. We agree with Montgomery and Culver that these tumors are more resistant to radiation than those on the face, possibly because squamous cell carcinoma of the face is not associated with such predominant infection. A pre-radiation treatment consisting of thoroughly cleansing the ulcer several times a day for a number of days might stimulate better healing. We often find that following radiation therapy the healed ulcer will break down, not as a malignant recurrence, but because of the accumulation of purulent secretion beneath the healed layer. When this occurred in our Case 19 a number of biopsies were taken from the edge of the ulcer. They all

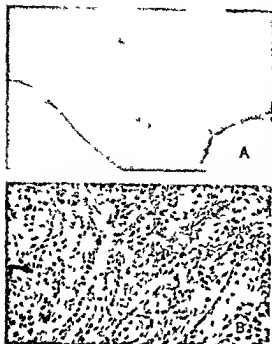


Fig. 2 Case 29. Healed squamous cell carcinoma of the foot with visceral metastases. A primary lesion. B photomicrograph showing squamous cell carcinoma of primary lesion.

tilages the periosteum or perichondrium constitutes an effective barrier which excludes the growths from the bone or cartilage for long periods.

Roentgenologically there is a variety of bone changes varying from periostitis (radiation and infectious) osteoporosis and osteomyelitis to areas of bone destruction and increased bone density. Eleven such cases, or 34 per cent were found in our series: humerus 3, metacarpal 1, digit, 1, femur 1, tibia 3, and metatarsal 2. In the presence of a carcinoma overlying the affected bone one does not wonder that some of these cases are interpreted as bony metastasis by the roentgenologist, the surgeon or both resulting in amputation which is not always indicated. This is well illustrated by our Case 20. Amputation was advised because of bony metastasis. The patient refused operation and was not seen for 3 years. We considered her among the deceased. However she was seen recently and proudly displayed her leg stating "I got

cured without youse doctors. I still have my leg without doin nothin'." Case 3 in our series had his arm amputated in 1929. The roentgenological report was "metastasis to the underlying bone." The treatment was undoubtedly indicated because of the extensive ulceration of the arm. The patient is still working, but one wonders how much the surgeon was influenced by the roentgenological report before he decided on amputation.

The cauliflower type is less destructive but has greater malignant tendencies, subject to recurrence and metastasis. However metastasis in carcinoma of the extremities is extremely rare. If at all it occurs late in the disease. De Asis explains this slow or late metastasis by the fact that the edges of the ulcer undergo thickening and induration, which are believed to squeeze the lumina of the lymphatic vessels, thus preventing the flow of the lymph which ordinarily carries the cancer cells. This explanation might be very consistent with the relatively benign course of the ulcerative type of carcinoma in which the edges of the ulcer are thickened and indurated. It also explains the relatively malignant course of the cauliflower type in which these factors are lacking in the majority of cases.

The regional lymph nodes are the first to be invaded although the majority of the enlarged nodes are secondarily involved from the infection of the primary lesion and are not malignant. A great number of these enlarged nodes disappear when the primary lesion is removed. In our own series 7 patients had palpable nodes, the smallest the size of a pea and the largest the size of an orange. Internal and osseous metastases, although rare have been reported in some instances. Mohr's case (quoted by Johnson) metastasized to the lungs, pleura, heart, and kidneys. He also quoted a case of Durand that metastasized to the iliac pelvic and lumbar lymph nodes and produced a metastatic tumor in the liver as large as an orange. One of De Asis's cases of carcinoma of the leg metastasized to both inguinal regions and to the liver as evidenced clinically by an enlarged liver with multiple nodules. One of the cases cited by Perez revealed general internal metastasis which was proved by autopsy.

# THE PRESENT STATUS OF CHRONIC OSTEOMYELITIS

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**B**ECAUSE it is relatively frequent and because it tends especially to affect the children of the poor who cannot pay for prolonged and often repeated hospitalization and the services of a private physician, chronic osteomyelitis is one of the most difficult problems encountered in the care of crippled children. Not only do these patients require prolonged hospitalization, but many of them need frequent dressings after they leave the hospital and, as will be shown, a considerable percentage of them are practically incurable.

We have reviewed 200 consecutive cases of chronic osteomyelitis which were admitted to the St. Louis unit of the Shriners' Hospital for Crippled Children, between the years 1924 and 1938 (6 per cent of 3,330 total admissions during this period). All of these patients gave histories of acute onset with fever and apparently their condition had resulted from an acute hematogenous osteomyelitis. No patients were admitted with chronic infection of the bone in whom the disease had resulted from a compound fracture or from the extension of an infection from neighboring soft tissues, except possibly extension into the bone from pyogenic joints. As we have not been able to separate these from the patients in whom the disease began in the bone, we have classed them all under the heading of chronic osteomyelitis. However, patients who had a primary pyogenic arthritis and who entered the hospital without chronic osteomyelitis were not included in this study. The series comprised 128 boys (64 per cent) and 72 girls (36 per cent). On admission their ages ranged from 10 months to 14 years and averaged 7 7/8 years. When admitted to the hospital the disease had been present from 12 days to 12 years and the average duration of the disease was 27 months.

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This hospital usually has a relatively large waiting list and patients are not admitted until they have been recommended by their physician and investigation has been completed to show that the parents of these children are not in a position to pay for private medical care. This precludes us from receiving patients with acute osteomyelitis.

In reviewing the histories of these patients we were interested in determining why they developed the disease. As to the cause of the acute osteomyelitis, nothing of importance was learned except that 25 per cent of the patients gave a history of a definite injury during the preceding week, and 40 per cent during the month preceding the development of the disease. With due allowance for the frequency of minor injuries in children, it seems probable that in a considerable percentage of the cases trauma plays a part in inaugurating the disease, or at least in determining the site of the primary focus. Preceding illness and foci of infection were not mentioned with sufficient frequency to be of etiological significance. It is our opinion that most of these patients were apparently normal, healthy children in whom the disease developed suddenly and for some unknown reason.



Fig. 1. A small localized osteomyelitis of the humerus, typical of a + lesion. There is no involvement of epiphyseal cartilage or neighboring joint. Acute onset with drainage of abscess 3 months later and sequestrectomy 5 months later. Small sinus still draining when last seen after 1 year.

showed chronic inflammatory changes but no malignancy. Similar findings were present when the entire ulcer was excised and examined. No amount of cleansing will make an infected malignant ulcer suitable for conservative surgery, but it might improve the effect of radiation therapy.

If we find that an ulcerative carcinoma does not respond to radiation it becomes a surgical problem. Further delay would only transform a superficial carcinoma to a deep seated one, cause further destruction of the underlying tissue from the chronic infection, and increase the surgical risk.

Age and physical status of the patient are other factors that determine whether the patient should be treated by radiation or surgery, regardless of size or type of lesion. One therefore, cannot make a hard and fast rule whether to treat squamous cell carcinoma of the extremities by surgery or radiation. Each patient must be treated individually.

The prognosis in squamous cell carcinoma of the extremities is very favorable. This disease runs a slow course and metastasizes late if at all. Though histologically malignant clinically it is a relatively benign cancer. Recurrence is less common than squamous cell carcinoma of any other part of the body.

#### SUMMARY

1 Squamous cell carcinoma of the extremities is comparatively rare. It comprises not more than 1 per cent of all carcinoma in different parts of the body.

2 It is more common in males than in females and the age incidence is higher than in any other malignancy.

3 Trauma is a contributing factor in a number of cases.

4 Metastasis is rare and late in the disease if it occurs at all.

5 The non ulcerating type is comparatively more malignant.

6 The ulcerating type causes a great deal of destruction of the underlying tissues resulting in various pathological changes in the bone which are often interpreted as "metastasis".

7 The treatment in the majority of cases is surgical. Radiation therapy is indicated in the superficial ulcerating types not amenable to conservative surgery because of the infection and the poor surgical risk.

8 The prognosis is very favorable. Though histologically malignant clinically it runs a relatively benign course.

9 Thirty two cases of squamous cell carcinoma of the extremities have been studied and the findings summarized.

#### REFERENCES

- 1 ADAMS F F Surg Clin N America April 1933 p 423
- 2 BRODERS A C Ann Surg 1921 73 147
- 3 BRANN M von Beitr z klin Chir 1903 37 227
- 4 DE ASIS C Ann Surg 1916 83 663
- 5 DEBELL P J and STEVENSON F D Surg Gynec & Obst 1936 63 222
- 6 DERRAND C Thèse doct Paris M 221 1839 p 222
- 7 FAY H J Cutan Dis incl Syph 1915 33 22
- 8 GESCHICKTER C F and COPELAND M M Tumors of Bone Am J of Cancer 1936 p 359
- 9 HEIMANN C Arch f klin Chir 1898 57 911
- 10 JOHNSON F M Ann Surg 1926 83 163
- 11 MONTGOMERY D W and CULVER C D New York M J & Rec 1923 118 64
- 12 PEREZ R F Am J Surg 1929 6 354
- 13 RUFFENFELD S Am J Cancer 1921 16 371
- 14 STEIGEL H Am J Cancer 1913 30 108
- 15 VOLKMANN R Samml klin Vortr Chir, 1883 No 107
- 16 WELLS R A The Spread of Tumours in the Human Body London J and A Churchill 1913
- 17 WEINWARTER A von Beitr z Statistik der Carcinome Stuttgart 1878
- 18 WERT K Beitr z klin Chir 1909 26 367



Fig 4 Massive destruction of the tibia demonstrating + + + + lesion There is involvement of the entire shaft, the epiphyseal cartilage at the 2 ends, as well as involvement of the knee and ankle joint Acute onset with drainage of abscess 6 days later Additional surgery has not been performed because of poor general condition and multiple involvement Drainage persists after 2 years

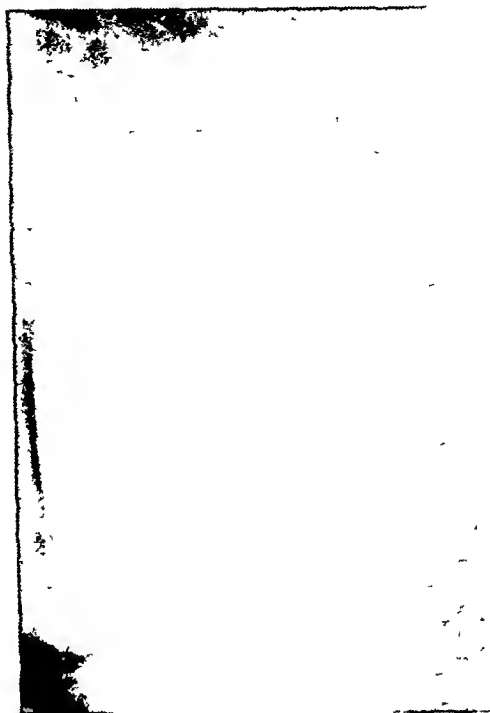


Fig 5 Extensive destruction in the femur demonstrating a + + + + lesion There is involvement of the entire shaft, epiphyseal cartilage at the 2 ends, and involvement of the hip joint Acute onset with drainage of abscess after 10 days Admitted to this hospital 3 months later Operation deferred because of poor general condition Several sequestra extruded and after 15 months all sinuses closed and have now been healed for 1 year

closed by the roentgenogram until sufficient time has elapsed for the bone to be eroded or for new bone to be formed (from about 10 days to 2 weeks)

diagnosis It is thus apparent that acute hematogenous osteomyelitis is frequently treated for some time as some other disease, especially rheumatism, and that the physicians in general practice who are the first to see these cases are not osteomyelitis conscious This is true even today as 6 of these 41 cases have occurred during the past 2 years It is also in order to reiterate that in the early stages of acute osteomyelitis, the affected bones cast normal shadows on the x-ray film and abnormalities of the bones are not dis-

The site of the primary lesion is shown in Table I It is to be noted that the large bones of the lower extremities (femora 95 and tibiae 72) account for 83.5 per cent of the total and that there were no instances in which the primary focus was in the spine or cranium. From a study of the x-ray pictures on admission it was not always possible to determine whether the disease began in the diaphysis or in the metaphysis, but in the great majority of instances the disease appeared to have begun in the metaphysis near the epiphyseal line In other words, the predominance of this disease is found in the large bones of the lower extremities which are most subjected to epiphyseal strains, and it suggests that this





Fig. 2. A more extensive process in the metaphyseal region of the femur demonstrating a +++ lesion. No involvement of epiphyseal cartilage or adjacent joint. There was an acute onset and treatment for inflammatory rheumatism was carried out for 4 months at which time the abscess was drained. Sequestrum extruded spontaneously after which the sinus healed and has remained healed for 18 months.



Fig. 3. An extensive involvement of the tibia demonstrating a +++ lesion. Most of the shaft has been destroyed but the process stops short of the upper and lower epiphyseal cartilages without any impairment in growth or adjacent joint function. Acute onset with drainage of abscess on fifth day. Sequestrectomy and saucerization 6 months later. Healed completely in 3 months and has remained healed for 3 years.

It was not possible in every case to determine how early the acute osteomyelitis was recognized but in 41 instances (20.5 per cent) it was stated that the patients were treated over periods of from 1 to 12 weeks for other conditions before a correct diagnosis was made. The false diagnoses and the number of times each was made are as follows: Rheumatism 15, typhoid fever 4, acute rheumatic fever 3, phlebitis 3, joint sprain 3, malaria 2, influenza 2, pneumonia 2, appendicitis (both operated) 2, fracture (without x ray) 2, blood poisoning 1, arthritis 1, tuberculosis 1.

In the majority of these a correct diagnosis was not made until large subcutaneous ab-

scesses had developed and in many instances not until these had ruptured and drained spontaneously. In others osteomyelitis was ruled out because of an early negative x ray and the erroneous diagnosis was adhered to until the x ray picture showed changes in the bone. In the 2 instances with a diagnosis of fracture x ray pictures were not taken. The 2 patients who were diagnosed as appendicitis cases were subjected to emergency appendectomies and normal appendices were said to have been removed. Both of these patients had osteomyelitis of the shaft of the right femur and it is probable that inflammation of the retroperitoneal lymph nodes caused abdominal symptoms which led to the erroneous

TABLE I—BONES INVOLVED PRIMARILY AND SECONDARILY AND LOCATION OF SECONDARY FOCI WITHIN THE BONE

Primary Foci			Secondary Foci			
Site	Number of cases	Cases with bone work during first week of illness	Metaphysis	Dia-physis	Differentiation not possible	Total
Humerus	11	2	6	5		11
Radius	2		1	0		1
Ulna	1		3	1		4
Femur	95	3	33	0		33
Tibia	72	3	7	0		7
Fibula	2		3	2		5
Foot	9	1			2	2
Phalanx					6	6
Mandible					4	4
Zygoma					2	2
Ilium	7				4	4
Rib	1				1	1
Scapula					1	1
Total	200	9	53	8	20	81

TABLE II—CASES SHOWING SECONDARY FOCI AND JOINT INVOLVEMENT ACCORDING TO BONES

Site of primary lesion	Total cases	Secondary foci	Adjacent joint involvement
Tibia	72	23	27 (20 knees, 7 ankles)
Femur	95	17	55 (14 knees, 41 hips)
Humerus	11	4	3 (2 shoulders, 1 elbow)
Other bones	22	6	15 (9 in feet, 5 hips from ilium, 1 elbow from radius)
Total	200	50	100

TABLE III—CASES OF SECONDARY FOCI AND JOINT INVOLVEMENT IN RELATION TO TYPE OF PRIMARY TREATMENT

Type of treatment	Total cases in entire series		Secondary foci		Adjacent joint involvement	
	number	per cent	number	per cent	number	per cent
Bone work in 1 week	9	4.5	1	11	1	11
Soft tissue drainage in 1 week	42	21	9	21	17	40
Bone work later	22	11	4	18	10	45
Soft tissue drainage later	62	31	23	37	35	56
Spontaneous rupture of abscess	18	9	5	28	11	61
No drainage and no treatment	47	23.5	8	17	26	55
Total	200		50	25	100	50

tation of movement and loss of function. These complications were present on admission and practically all of them developed during, or shortly after, the acute stage of the disease. It is recognized that metastatic foci may develop late in chronic osteomyelitis, but these are relatively rare when compared with the number which develop early in the process.

We believe that in acute osteomyelitis the bone should be drained as soon as possible after the onset of the disease provided the patient is in condition to stand the operation, and we believe that early and adequate drainage of the bone tends to prevent or limit the extent of the chronic bone infection and to decrease the number of instances in which joints or other bones will be involved (4, 5). This study was undertaken with the hope of furnishing evidence for or against the above beliefs. We have arbitrarily fixed the first week of the disease as the period during which we consider operative intervention as being early, but we by no means consider operation at from 6 to 7 days as really early enough. Unfortunately for our study, the bone was

opened during the first week of the disease in only 9 patients in the entire series (4.5 per cent, Table III). Among these 9 patients (femur 3, tibia 3, humerus 2, and foot 1), the adjacent joint was involved in only 1 instance and there was only 1 secondary focus in another bone (11.1 per cent as compared with 50 per cent and 25 per cent for the entire series). However, the number of patients so treated is too small to warrant definite conclusions as to the efficacy of this form of treatment.

It is further to be noted from Table III that soft tissue drainage, which was done in 42 patients during the first week, did not greatly decrease the number of complications, while drainage of the bone after the first week did not increase the number of complications. In the patients who had soft tissue drainage after the first week or in whom the abscesses

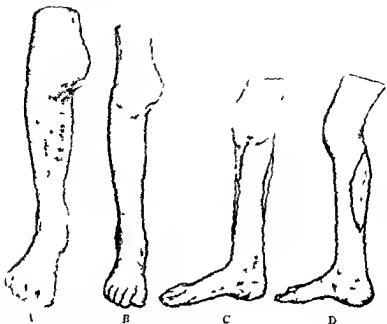


Fig. 6. A Broad adherent scar covering upper two thirds of tibia resulting from healed osteomyelitis. B Hair line scar following excision of the original scar and shifting of pedicle flap to cover the defect. C Double pedicle flap approximately 2 inches in width outlined with dye to show type of flap which is used. D Split thickness graft on posteromedial aspect of leg outlined with dye which is used to fill the defect remaining after the flap is shifted.

may be an important factor in creating a point of lowered resistance where casual organisms in the blood stream may settle and find conditions favorable for growth.

However 40 of 51 secondary foci developed in the metaphyseal regions of the femora and tibia and most of these occurred while the patients were ill in bed and trauma was not a factor. This inclines us to accept the theory of Hobo who demonstrated dilated capillary loops in the metaphysis adjacent to the epiphyseal cartilage plate. He found that bacteria and carbon particles injected into the blood of experimental animals tended to localize in these loops where the blood stream was slowed. Yet the volume of the metaphyseal regions of these 4 bones is hardly sufficient to explain the marked predilection of the disease for these areas. Likewise, we recall the large sinusoids of the spleen and red bone marrow where the blood current practically ceases at times and wonder why

these areas are not affected if the localization is due to a slowing of the blood stream. There were no patients with osteomyelitis of the vertebra in this series and only 7 in which the disease began in the pelvis. It is thus evident that we have no satisfactory explanation for the fact that in 83 per cent the disease began in the metaphyses of the femora and tibia.

We were interested in determining the type of treatment which these patients had received during the stage of their acute illness and if possible correlating this with the amount of bone involvement with the number of instances in which joints were involved and with those in which foci developed in other bones. It is to be noted from Table II, that in 50 per cent of the patients there was involvement of the joint adjacent to the focus in the bone and in 25 per cent of the patients secondary foci developed in other bones. Many of the joints were destroyed and others showed a variable amount of lim-

The operations have been performed by or under the direct supervision of the various orthopedic surgeons on the staff of the Shriners' Hospital during this period and always, we believe, by men competent to do as adequate a saucerization as could reasonably be expected on the various patients assigned to them. Consequently we have no quarrel with the quality of the surgery which these patients have received. This is important because, as will be mentioned later, we have not cured all our patients. We believe that most of the failures have been due to incomplete removal of infected bone. This occurred because in some cases it is absolutely impossible to remove all of the infected bone without the grave danger of producing greater and permanent disability in the extremity.

At present the procedure at the Shriners' Hospital is as follows. The operation is performed under a tourniquet when one can be used. After the wide saucerization is completed, the wound is packed with dry, fine mesh gauze in order to control the bleeding, and a dry dressing is applied. A cast is not applied unless there is danger of a fracture of the residual shaft or involucrum from slight violence. On the third postoperative day, the gauze pack is removed under gas anesthesia and a vaseline gauze pack is inserted. This is changed at intervals of from 2 to 4 days. After the first 2 or 3 dressings the wounds are lined by granulation tissue and little pain is experienced by the patients. If at any time the granulations do not appear healthy, wet dressings are used and the wounds are irrigated with normal salt solution for a few days. Vaseline gauze then is again substituted. This method is continued until the wound is healed or the patient leaves the hospital. It seems to be just as efficient as the Orr method and eliminates the odor which is so objectionable when the latter method is used.

One of us (J. A. K.)—most of whose work is carried on in other hospitals where it is necessary that the hospital stay be as short as possible—routinely uses the vaseline pack and plaster cast immobilization as advocated by Winnett Orr. The procedure which has been described by him (6) has been followed with a

reasonable degree of accuracy. Three slight modifications have been introduced and it is believed that they have been of some value. (1) The surrounding skin is covered with heavy zinc oxide ointment to protect it from the scalds and small furuncles which are so common when pus remains in contact with the skin under a cast. (2) In unusually foul and odoriferous infections, iodoform gauze is mixed with the vaseline gauze in an attempt at least to change the odor. (3) Where a reasonably satisfactory operation has been performed, large deep wounds are closed with a single layer of through-and-through sutures of silkworm gut, leaving wicks of vaseline gauze extending down to the bone and projecting at intervals between the sutures. The sutures and the vaseline gauze wicks are removed after the usual interval of 2 to 4 weeks and the small cavities remaining are repacked with vaseline gauze and a new cast is applied. By this method it is frequently possible to invaginate the soft tissues into deep cavities in the bone, and not only to shorten the time of healing and to limit the width of the scar but also to render healing more certain.

In addition to the above, we have used the Carrel-Dakin method and various types of wet dressings and other chlorine antiseptics. A few years ago when the newer mercurial antiseptics appeared we packed our wounds with gauze impregnated with merthiolate ointment, but we could not persuade ourselves that the wounds healed any more rapidly or more surely than did similar ones in which ordinary vaseline gauze had been used. We have even used gauze impregnated with ordinary hog lard and it seems to work just as well as any of the other preparations. We tried this in order to find some substance which would always be available to those patients who live in inaccessible places and who are required to do their own dressings. We have not used maggots because they are expensive, and we have not believed that they have any especial advantage unless the wound contains necrotic tissue. Our postoperative wounds contain no loose fragments of dead bone which the larvæ can bring up and deposit on the surface and relatively little necrotic soft tissue. The infected bone which

TABLE IV.—DEGREE OF PRIMARY DESTRUCTION AND END-RESULT IN RELATION TO TYPE OF PRIMARY TREATMENT

Type of treatment	Amount of primary destruction				Total cases in series	End result			No. x rays taken up
	+	++	+++	++++		Good	Fair	Poor	
Bone work in 1 week	0	3	4	3	0	5	3	4	2
Bone work later	3	3	9	5	22	8	5	4	5
Soft tissue drainage in 1 week	8	4	16	4	42	9	12	26	3
Soft tissue drainage later	6	16	18	2	62	18	18	23	3
Spontaneous plus care	4	4	7	3	18	6	3	3	3
No drainage and no treatment	3	21	18	3	47	10	11	19	3
Total	4	61	71	41	100	51	56	51	2

ruptured spontaneously the incidence of complications was relatively high.

In 47 patients no abscesses had been drained or had ruptured spontaneously before admission and in these the number of secondary foci was relatively low (17 per cent) while the joint involvement was relatively high (55 per cent). It is believed that in many of this group the primary infection was one of rather low virulence.

In the 50 patients who developed secondary foci there were 81 metastatic lesions (Table I) an average of 1.62 lesions per patient. Thus a patient who develops one secondary focus is liable to develop others. Thirty-eight of the 50 patients with secondary foci were among the 100 patients in whom the adjacent joint was involved. This may be interpreted as evidence that secondary foci are more frequent among patients in whom (1) the adjacent joint is involved, (2) in whom the infection has broken through the epiphyseal cartilage plate to involve the epiphysis, or (3) in whom the primary disease is relatively extensive.

We have also divided these patients into 4 groups, depending upon the extent of the pathology in the bone where the primary focus occurred as shown by the x rays made on admission. These are classed as +, ++,

+++ +++++ pathology in the bone and naturally the groups are not sharply demarcated. Figures 1, 2, 3, 4 and 5 illustrate lesions which we regard as being typical of each group. We have attempted to correlate the extent of the bone pathology present on admission with the type of treatment which these patients received during their acute illness (Table IV). A study of this table, however, does not permit the drawing of any definite conclusions and it appears that the degree of bone destruction was not definitely influenced by the early treatment which was given in this series. Apparently the disease tends to be self limited; the bone is invaded very rapidly, and the amount of bone destroyed varies directly with the virulence of the invading organism and inversely with the resistance of the individual. If drainage is to be effective in limiting the spread of the primary focus it must be done very early in the disease.

As most of these patients came from the country or small towns, cultures of the loci or of the blood were rarely made during the acute illness, and we have no data regarding the organisms responsible for the disease. Neither have we any information regarding the frequency of septicemia, except that 3 of the patients were said to have had positive blood cultures.

#### TREATMENT

The treatment which these patients have received has been fairly uniform throughout the 14 year period. Most of the patients have been operated upon and the operation which we perform consists of the removal of any sequestra encountered and a wide saucerization of the cavity. As much as possible of the chronically infected bone is removed without the amputation or resection of bone. Care is taken not to curtail the joint or to destroy epiphyseal cartilages and we avoid the leaving of deep bone cavities with overhanging edges or tunnels through the bone. These can be filled with muscle flaps and may heal but experience has shown that in the majority of these in which healing occurs the disease recurs and the operations fail to give satisfactory results.

accomplish the purpose for which they were devised, namely, removal of all of the infected bone and the creation of a wound which can heal from within outward without leaving a dead space which will harbor chronic infection. Fortunately, in 61.3 per cent of our patients followed for 3 years or longer, the wounds healed and remained healed for 3 years or more in spite of incomplete removal of infected bone. In 38.7 per cent of this same group it was not practicable to create sufficiently favorable conditions by operative procedures to arrest the disease over the 3 year period.

Our observations lead us to believe that in any extensive series of patients with chronic osteomyelitis there is a considerable number (probably one-third) in whom, because of the extent of the involvement, permanent cure is impossible without complete, or almost complete, removal of the entire bone which is involved. We look with grave suspicion upon the various series of such cases in the literature in which all, or nearly all, of a given series were cured by one means or another (1). We believe that it is time the medical profession admitted this and realized that in the treatment of acute osteomyelitis the prevention of widespread destruction of bone is almost as important as is the saving of the life of the patient.

In addition to checking our patients as to whether or not the disease appeared to have been arrested, we have also evaluated them on a functional basis (Table IV) and endeavored to correlate the result with the treatment which the patients received during the acute stage of the disease. Poor results are those with a marked deformity, complete loss of function in the adjacent joint, complete destruction of an epiphyseal line, or persistent drainage, and these comprised 35.5 per cent of the 200 patients. Fair results are patients showing a slight or moderate deformity, as some impairment of joint function, slight disturbance of growth, or a slight amount of drainage, and these comprised 28 per cent of the series. Good results represent those patients in whom the disease appeared to have been arrested without residual deformity or important disturbance in growth

and without significant loss of function in the adjacent joints. This result was obtained by us in only 25.5 per cent of the 200 patients.

In some patients extensive scars cover the bone after healing is complete. These scars are attached to the bone, are poorly supplied with blood, and are covered by a thin layer of epithelium. They tend to break down with superficial ulcerations following relatively slight trauma. They heal very slowly and because of their persistent character, are often mistaken by the patient for a flare-up in the bone infection itself. Because of these characteristics and because these scars are unsightly, we feel that they should be excised and replaced by a hair line scar if possible. The defect remaining after excision of the scar is sometimes small enough so that the neighboring skin and subcutaneous tissue can be undermined and closed over the defect without undue tension. Sometimes, however, especially in the tibia, the defect is so large that this is impossible without increasing the tension on the skin edges to such an extent that a slough may occur. It is important to procure a healthy soft tissue covering for the bone. In order to obtain this result it may be necessary to raise a double pedicle flap on the medial aspect of the leg and shift it laterally to cover the exposed portion of the bone completely. The defect on the medial aspect resulting from the shifting of the double pedicle flap is then covered with a split thickness graft. The result in such a case is shown in Figure 6.

#### SUMMARY

Of 200 consecutive patients with chronic osteomyelitis, 41 had been treated for more than 1 week with an erroneous diagnosis during the acute stage of the process and in only 9 was the bone drained during the first week of the disease.

Consequently, at least 191 of these patients had been treated conservatively or by delayed operation. In this entire series the incidence of secondary bone foci was 25 per cent and the involvement of the neighboring joint was 50 per cent.

By means of the standard surgical procedures and prolonged hospitalization with

is left is beyond the reach of maggots or of any chemical or other agent which can be applied to the surface of the wound. Hence, we do not use bacteriophage. It has been amply demonstrated that this agent is inhibited by the body fluids and that bacteria in chronic infections quickly become immune to a bacteriophage.

Observations upon these and other patients with chronic osteomyelitis convince us that the permanent cure of chronic osteomyelitis in children over 3 years of age depends upon the thoroughness of the operation and not upon the after treatment. If all of the infected bone can be removed, the wound will heal and stay healed if it is kept open so that it heals from within out and it matters little what type of dressing is used as long as it is not actually harmful. It should also be remembered that the smaller the opening, the more rapid the healing as long as drainage is assured. Hence, our method of partial closure at the operation for saucerization.

If all of the infected bone is not removed, the wound may heal or may continue to drain indefinitely depending upon the activity of the infection and the geography of the wound, but even if it heals, the wound remains a potential source of trouble because the infection may become active again and cause a flare up of the old disease. This is because human beings do not tend to develop an effective degree of immunity to the staphylococcus or to the streptococcus regardless of the period of contact with the organisms, nor has any means been found as yet which will confer such an immunity. (2)

#### RESULTS OF TREATMENT

Of the 200 patients in this series it has been possible to follow 98 of them over a period of 3 years or longer. Of these, 60 were apparently cured and had shown no evidence of active disease during the 3 year or longer period while 38 had evidence of active disease during that time. Of these 38 failures 24 had been healed and apparently cured during part of the 3 year or longer period, but the disease had recurred and abscesses had formed. In the remaining 14 patients the disease had remained clinically active during the entire

period of observation. In these 14 cases of persistent drainage, there was involvement of epiphyseal plates or of neighboring joints.

Of the remaining 102 patients it was possible to follow 38 of them over a period of from 2 to 3 years. Of these, 16 had remained clinically healed for at least 2 years while the remaining 22 revealed evidence of some activity during this time.

Thirty-seven of the 64 remaining patients were followed for a period of from 1 to 2 years. Of these, 22 were clinically well and the 15 remaining still had evidence of active disease. There remain 27 patients who failed to return for additional observation or were followed for less than 1 year. There were 2 amputations and 1 death in the series of 200 patients. The death resulted from an attempt to do an adequate sequestrectomy on an involved hip joint. Only 1 resection was performed and this was for removal of a portion of 1 rib.

Our failure to cure 38.7 per cent of the 98 patients who were followed for 3 years or more is not entirely due to the extent of the bone pathology present on admission because they were graded as follows: 4, ++, 18, +++, 9, +++ and 7, ++++, while the 3 year cures consisted of 7, +, 24, ++, 18, +++, and 11, ++++ involvement. In regard to the bones affected, the 3 year cures were femur, 33, tibia 14, humerus 1 and other bones, 10. Our failures were due to our inability to arrest the activity of the disease. This is due to the fact that in a bone which is chronically infected the infection is by no means limited to the abscess cavity or to the adjacent bone, but eburnation of bone extends for a considerable distance up the shaft and this contains minute temporarily walled-off nests of infected granulation tissue which may give rise to an active infection in the future. Furthermore it is the rule rather than the exception for a bone which is extensively involved to show pathology throughout the entire extent of the bone in the involved area. At the saucerization operation a part of the area is always left to preserve the integrity of the shaft, and this so called pencil of bone is always infected bone. It is thus evident that relatively few of our saucerization operations

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# A BACTERIOLOGICAL STUDY OF THE PERITONEAL FLUID IN PERFORATED PEPTIC ULCERS

MARSHALL DAVISON, B.S., M.D., F.A.C.S., LEON J. ARIES, M.S., M.D., and  
ISADORE PILOT, B.S., M.D., Chicago, Illinois

**P**ERFORATION of a peptic ulcer with an immediate diffuse contamination of the peritoneal cavity has long been known to be a condition demanding immediate surgical intervention. It has been empirically recognized that the morbidity and mortality in such patients is determined to a large extent not so much by the character of the material which has already accumulated in the peritoneum as by the length of time that this contamination has been present. The recognition of the difference between early chemical peritonitis and the succeeding bacterial peritonitis is not new, but little study has been made of the type of bacterial peritonitis once this complication has occurred.

The literature on the subject is rather brief. Published monographs lead one to believe that such exudates are innocuous in the first hours. Ulrich, Moynihan, and Alexander state that there is no growth in the peritoneal fluid up to 12 and 18 hours, conversely Bruett reports 74 per cent positive cultures following perforations between the sixth and twelfth hours, and 93 per cent positive cultures in patients coming to operation 12 hours or more after perforation.

In a series of collected cases in which the peritoneal fluid following perforated ulcers has been cultured, Judine obtained 89.3 per cent positive cultures in the first 12 hours, and 100 per cent positive cultures in the second 12 hours. He also showed that those patients with sterile cultures had a smooth postoperative course with no complications. The bacterial flora found in his series consisted mostly of streptococci and staphylococci.

Vendt demonstrated bacteria in 77 per cent of his cultures of 16 cases but found few bacteria in each instance. The non-hemolytic

streptococcus dominated the picture, occurring in 90 per cent of the positive cases.

Dudgeon and Maybury report a series of 23 cases. Ten of these peritoneal fluids contained diplococci or streptococci. The authors believe that the streptococci found in the peritoneum in cases of gastric and duodenal perforations are derived from the food and have caused infection at the base of the ulcer and in the peritoneum.

In our own experience and that of other clinics (5), the greatest number of casualties and complications are due to a bacterial peritonitis. It has been our belief that a relative prognosis may be made if we could know whether or not organisms are present at the time of operation and, if present, what types.

Before considering our series of perforated peptic ulcers that were studied bacteriologically, a review of the cases of perforated ulcers for the year 1937 at the Cook County Hospital is desirable. Of 652 patients who were treated for peptic ulcer or one of its complications, 76 patients had perforations, of which 43 (56.5 per cent) were duodenal, 26 (34.2 per cent) were gastric, and 2 (2.6 per cent) were gastrojejunal. Five cases of this group were not operated upon.

Patients entering the Cook County Hospital with the diagnosis of perforated peptic ulcer were brought to surgery as soon as they could be adequately prepared. Such preparation consisted of aspiration of the stomach contents by the aid of a Levine tube and continuous suction, the intravenous administration of saline and glucose solution, and morphine and atropine. Thirty-four patients with perforated ulcers that came to operation had cultures made of the peritoneum.

## PROCEDURE

Immediately upon the opening of the peritoneal cavity fluid material was aspirated into

From the Surgical Service of the Cook County Hospital, the Division of Surgery, Northwestern University Medical School, and the Department of Pathology and Bacteriology, University of Illinois College of Medicine.

adequate after treatment, it was possible to obtain healing in only 61.3 per cent of 98 cases which we followed for 3 years or longer. In 38.7 per cent of these the sinuses continued to drain or the disease healed and recurred during the period of observation.

In the series of 200 cases we consider our end results as poor in 35.5 per cent, fair in 28 per cent, good in 25.5 per cent, and unknown in 11 per cent.

We believe that the cure of the disease depends upon the ability of the surgeon to perform an adequate operation and remove all of the infected bone and that the type of after treatment is relatively unimportant, provided adequate drainage is maintained.

In about 40 per cent of the patients, adequate surgery is not feasible and such patients are practically incurable.

We believe that early diagnosis of acute hematogenous osteomyelitis and prompt drainage of the focus in the bone is the most important factor in the prevention of chronic osteomyelitis with its attendant economic waste and crippling.

#### BIBLIOGRAPHY

- 1 ALBEE F H The treatment of osteomyelitis by bacteriophage J Bone & Joint Surg, 1933 15 58
- 2 BUCHMAN J Use of staphylococcus toxoid in treatment of chronic osteomyelitis J Am M Ass 1937 108 1151
- 3 HOSO T Pathogenesis of osteomyelitis Acta scholae med univ imp Kyoto 1921 4 1
- 4 KEY J A Prevention of chronic osteomyelitis J Missouri M Ass 1936 33 30
- 5 Idem Rational treatment of acute hematogenous osteomyelitis J Am M Ass 1938 December 10
- 6 ORS H W Treatment of osteomyelitis and other infected wounds by drainage and rest Sur Gynec & Obst 1927 45 446

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streptococcus dominated the picture, occurring in 90 per cent of the positive cases.

Dudgeon and Maybury report a series of 23 cases. Ten of these peritoneal fluids contained diplococci or streptococci. The authors believe that the streptococci found in the peritoneum in cases of gastric and duodenal perforations are derived from the food and have caused infection at the base of the ulcer and in the peritoneum.

In our own experience and that of other clinics (5), the greatest number of casualties and complications are due to a bacterial peritonitis. It has been our belief that a relative prognosis may be made if we could know whether or not organisms are present at the time of operation and, if present, what types.

Before considering our series of perforated peptic ulcers that were studied bacteriologically, a review of the cases of perforated ulcers for the year 1937 at the Cook County Hospital is desirable. Of 652 patients who were treated for peptic ulcer or one of its complications, 76 patients had perforations, of which 43 (56.5 per cent) were duodenal, 26 (34.2 per cent) were gastric, and 2 (2.6 per cent) were gastrojejunal. Five cases of this group were not operated upon.

Patients entering the Cook County Hospital with the diagnosis of perforated peptic ulcer were brought to surgery as soon as they could be adequately prepared. Such preparation consisted of aspiration of the stomach contents by the aid of a Levine tube and continuous suction, the intravenous administration of saline and glucose solution, and morphine and atropine. Thirty-four patients with perforated ulcers that came to operation had cultures made of the peritoneum.

## PROCEDURE

Immediately upon the opening of the peritoneal cavity fluid material was aspirated into

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TABLE I — AGE INCIDENCE

Age in years	Number of cases	Number of deaths
10-20	3	—
21-30	10	1
31-40	21	4
41-50	16	6
51-60	24	5
61-70	3	3
71-80	1	—

TABLE II — MORTALITY ACCORDING TO LOCATION OF LESION

Location of lesion	Number of cases	Number of deaths	Deaths per cent
Gastrostomy	1	8	100
Duodenal	41	6	14
Gastric	26	3	10
No operation	2	4	20

TABLE III — CULTURE RECORD IN 34 CASES

Hours elapsed	Cases	Deaths		Positive culture	
		Number	Per cent	Number	Per cent
0-6	11	3	27.2	3	28
6-12	2	4	50	0	75
12-18	6	3	50	8	33
18-24	4	3	75	4	100
24-48	4	4	100	3	75
Over 48	1	0	0	1	100
	34	16	46.8	18	52.9

a sterile syringe placed in a sterile test tube, and transferred to the bacteriology laboratory. Numerous specimens collected were discarded as they had been allowed to stand at room temperature for a length of time sufficient to allow bacteria to be destroyed before they could be placed on a media conducive to growth. Direct smears were not made routinely, as the presence of alimentary debris too frequently made it difficult to identify organisms. The samples were then cultured in the following manner:

Ascitic blood agar media was used to isolate streptococci. This is a 20 per cent ascitic fluid with one half cubic centimeter of blood added to 8 cubic centimeters of meat infusion agar. Several loops of the material to be cul-

TABLE IV — COURSE IN 6 POSITIVE CULTURE CASES

Case number	Hours elapsed	Location	Organisms	Course
14	8	Duodenum	Bacilli + coli	Penetrating 3 days actively course
16	12	Pylorus	Bacillus pyocyaneus	Mild course
18	12	Pylorus	Sarcinomyces cerevisiae	Mild
27	20	Pylorus	Streptococcus viridans (colonies few)	Wound infection
28	22	Duodenum	Staphylococcus albus	Wound infection
34	7 days	Pylorus	Hemolytic bacillus coli	Perforation took 6 days to heal

tured were added to this media and pour plates were made. These were examined in 24, 48 and 72 hours. The colonies obtained were then stained by Gram's method, and the gram negative colonies were replated on Endos' media. Organisms which were still unidentified were then placed on the various sugar media and a final diagnosis made by their fermentative properties. Anaerobic organisms were sought by making cultures from the original fluid on the ascitic blood agar slants from which oxygen had been absorbed by pyrogallic acid alkali mixture.

Thirty four cases with perforations were cultured. Twenty perforations were located in the stomach and 14 in the duodenum. Three (8.8 per cent) of the 34 perforations occurred in women, 2 were located in the duodenum.

The most frequent organisms found were the *Bacillus coli* and the hemolytic *Bacillus coli*. Second in frequency was the *Streptococcus hemolyticus* of both alpha and beta types next most frequent was the *Staphylococcus*, and in 3 instances anaerobic bacteria were isolated, one of which was of a hemolytic variety. In addition to these 1 *Bacillus pyocyaneus* and 1 yeast fungus were isolated. Eighteen or 53 per cent, of the 34 cases had positive cultures. There were 16 deaths among the 34 cases (Table III). Twelve of the 16 deaths were associated with bacteria of a marked pathogenic nature. Six patients with positive cultures recovered as shown in Table IV.

TABLE V.

Case number	Hours from perforation	Location	Hours post-operative to death	Age	Cause of death
5	5	Stomach	18	60	Shock
9	6	Stomach	2	34	Shock
25	18	Duodenum	6	45	Shock
30	28	Duodenum	24	72	Age-shock

All the cases with *Bacillus pyocyaneus*, yeast infection, and *Staphylococcus albus* had mild postoperative reactions in spite of wound infections. Of those infected with *Bacillus coli*, 1 had a 7 day history with perforation into the lesser omental bursa which was well walled off as an abscess and did not contaminate the general peritoneal cavity. The second had *Bacillus coli* in the free peritoneal cavity and ran a stormy postoperative course with generalized peritonitis, resulting in many weeks' stay in the hospital.

There were 4 deaths in 34 cases in which the patients had sterile cultures. In spite of this fact, the death in each case was prior to 24 hours following operation (Table I).

The majority of positive cultures occurred after the sixth hour of perforation, cultures of *Bacillus coli* were present in only 2 instances before the twelfth hour. Anaerobic bacteria were found only after the eighteenth hour. Lohr and Clavel believe that the presence of anaerobic organisms are encountered only as secondary invaders. They are usually found in localized abscesses and may arise from neighboring intestinal loops. All patients having cultures containing both streptococci and *Bacillus coli* died of diffuse peritonitis. The 2 patients with subphrenic abscess who came to postmortem examination had pure cultures of *Bacillus coli* in great quantities. All the positive cultures of streptococci were found in cases of perforation of the stomach, while *Bacilli coli* were found in the stomach or in the duodenum, either alone or in combination with staphylococci, streptococci, and anaerobes.

It is interesting to note the marked change in the bacterial flora in the second 6 hours following perforation. The presence of streptococci and *Bacillus coli* then appear in the peritoneal cavity, and their presence may be

explained on the theory of invasion of the upper bowel by organisms normally found only in the lower intestinal tract. The presence of an early "chemical peritonitis" causes a cessation of peristalsis with a concomitant cessation of secretion of hydrochloric acid, thus allowing for a proximal migration of bacteria from the lower bowel. The quantitative acid secretion in the stomach, therefore, may be responsible for the type of organism found. Streptococci and staphylococci are the organisms most sensitive to the presence of acid. The fact that organisms are infrequent in the early hours following perforation accounts for the fact that few of these patients develop a bacterial peritonitis, the more time elapsing following the perforation the more pathogenic the type of organism. Thus, patients having sterile cultures follow an uneventful postoperative course and do not develop complications.

The clinical course and prognosis in perforated ulcer may be determined by the bacteriological flora as is evidenced by the following case.

The patient, a laborer, aged 27 years, entered the hospital with diffuse abdominal pain present for 5 hours. The onset of the pain was sudden and severe in the upper abdomen spreading rapidly to the lower abdomen. There was no previous gastro-intestinal complaint. Physical examination revealed a well nourished young man lying quietly in bed with a rigid abdominal wall, absence of peristaltic sounds and obliteration of liver dullness. Fluoroscopy revealed a large air bubble beneath the diaphragm confirming the diagnosis of perforated peptic ulcer. Operation was performed within 6 hours after the onset of symptoms. A culture was taken upon opening the peritoneal cavity and 1200 cubic centimeters of a turbid fluid was aspirated from the peritoneal cavity and pelvis. The ulcer one half centimeter in diameter with a soft friable margin was closed with linen suture, and the abdomen was closed without drainage. Continuous gastric suction and supportive treatment were instituted after operation. The abdomen began to distend after the twenty-eighth hour in spite of the gastric decompression, temperature rose to 103 degrees. Transfusion of 350 cubic centimeters of blood was given on the second and third postoperative days because of the patient's poor condition. There were no intestinal sounds at any time and the patient became progressively worse in spite of all therapy and died on the fifth postoperative day from a diffuse peritonitis. The bacteriologist reported the presence of streptococci, *Bacilli coli* and proteus. The diffuse contami-

nation of the peritoneal cavity by such pathogenic organisms in the early hours following perforation offers a poor prognosis and we were cognizant of this fact within 40 hours.

There is no indication for draining those patients who have sterile material in their peritoneal cavities. The significance of a lower mortality rate (22.3 per cent) in the past year at the Cook County Hospital is due to the fact that the majority of patients, namely 37 of the 76 cases, were operated upon in the first 12 hours after perforation and in no patient operated upon was there a drain introduced into the peritoneal cavity.

#### CONCLUSIONS

1. Certain positive cultures from the peritoneal fluid in perforated peptic ulcers offer a prognostic significance as to the clinical course.
2. Cultures taken in the first 6 hours are usually sterile but when positive offer a poor prognosis.
3. The most frequent organisms found are the *Bacillus coli* and the streptococcus.
4. When cultures are sterile the postoperative course is smooth and the mortality is low.
5. The presence of pathogenic organisms in the cultures is associated clinically with complications and are directly responsible for the mortality and morbidity.

6. Drainage is indicated only in patients operated upon many hours following perforation, and then this can be construed only as an heroic treatment.

We wish to thank Miss Silka Stocker and Miss Kathryn E. Buck for their technical assistance.

#### BIBLIOGRAPHY

1. ALEXANDER. Quoted by C. L. Gibson. *Am J M Sc* 1923 165 809.
2. BRUET H. Bacteriologic considerations of excision of perforated gastric and duodenal ulcers. *Beitr z klin Chir* 19 6 138 601.
3. CLAVEL C and CLAVEL C. Bacteriologie des eporchements péritoneaux des ulcères gastro duodénaux perforés. *Lyon chir* 1933 30 264-283.
4. L. S. DUNGEON MAYBURY B. C. The bacteriology of the peritoneal exudate in cases of perforation of the stomach and duodenum. *Lancet* 1915 2 370 81.
5. FLEMMING B. L. Acute perforation of duodenal ulcers causes of death and a consideration of treatment. *J Am M Ass* 1931 97 6-11.
6. JUDINE S. S. Statistique de 116 cas d'ulcères perforés de l'estomac et du duodénum. *J de chir* 1931 28 159.
7. LOHR W. Etiologic significance of anaerobic bacteria in perforating peritonitis complicating gastric and duodenal ulcers. *Deutsche Zeitsch f Chir* 1929 214 103-134.
8. MORRIS H. *Abdominal Operations* Vol 1 p 230 Philadelphia W. B. Saunders 1926.
9. ULRICH P. De la gastro-pyloréctomie et de la gastro-pyloréctomie immédiates dans le traitement des ulcères perforés de l'estomac et du duodénum. *Rev de chir* 1931 41 461.
10. VANDT D. Contribution to our knowledge of the bacteriology of peritonitides due to ulcers. *Inaugural Dissertation* Jena 1923.

# THE USE OF NEOSYNEPHRINE IN SPINAL ANESTHESIA

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ONE of the difficulties encountered during the administration of spinal anesthesia is the maintenance of a stable level of blood pressure. The drugs commonly used for this purpose are epinephrine and ephedrine. Both produce an increase in heart rate with a tendency to arrhythmia and are stimulants of the central nervous system. Epinephrine when given subcutaneously or preferably into the muscle produces only an evanescent and inconstant rise in blood pressure, administered intravenously the rise in blood pressure may be marked but is transient. Its action on the heart is marked, ventricular fibrillation has been reported after its intravenous use and pulmonary edema may be produced. Ephedrine has a more prolonged and less violent action on the cardiovascular apparatus but similar to epinephrine it increases the heart rate and nervous tension. The well premedicated conscious patient may become "jittery" after its use.

A brief series of spinal anesthetics has been reported by Tovell who used benzedrine for the control of blood pressure. Our interest in the use of neosynephrine as a peripheral vasoconstrictor was aroused by the work of Carl A. Johnson (2, 3) who showed in a series of animal and clinical experiments that the subcutaneous injection of this drug is followed by an increase in blood pressure, a slowing of the heart rate, and that therapeutic doses such as 5 to 10 milligrams did not produce nervousness and anxiety. The previous literature on the subject can be found in his two articles. Johnson did not find any abnormal cardiac mechanism following its repeated use and found it valuable in combating the hypotension in shock and hemorrhage following operations. It occurred to us that if the drug was so effective in raising a low blood pressure, it might be advantageously used in smaller

doses as a preventive against the fall in blood pressure following the induction of spinal anesthesia. A preliminary report on our first 50 cases was made in October, 1937 (1). In January, 1938, Lorhan and Oliverio reported a series of 30 cases and concluded that the drug could be repeated without losing its effect but without the toxic phenomena observed with ephedrine. They stated that the action of the drug was rapid and that blood pressure was maintained for at least 30 minutes following its injection. They were impressed with the rate, rhythm, and volume of the pulse after its use.

We are reporting a series of 163 cases of spinal anesthesia administered in conjunction with the use of neosynephrine. For a control series we selected 100 operations done under spinal anesthesia in which ephedrine was used for the control of blood pressure. The neosynephrine group has been subdivided into low and high spinal anesthetics. In 113 low spinal anesthetics the loss of sensation extended to the umbilicus or slightly above, in the 50 high anesthetics the level of the anesthesia was at the costal margin or above in 60 per cent, midway between umbilicus and xyphoid process in 14 per cent, and to the umbilicus in 26 per cent. Every effort was made to select as nearly as possible a similar control group in which we have 50 low and 50 high spinal anesthetics. The anesthetic drugs used and their dosage will be discussed later.

## PROCEDURE

Blood pressure and pulse were determined while the patient was in the ward and then again after reaching the operating room. Following the injection of the vasoconstrictor, readings were made every 5 minutes until the operation was completed. Spinal anesthesia was induced within 5 minutes of the injection of neosynephrine or ephedrine, these were injected into the deltoid muscle and the site of injection was not massaged. Excluded from

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nation of the peritoneal cavity by such pathogenic organisms in the early hours following perforation offers a poor prognosis and we were cognizant of this fact within 40 hours.

There is no indication for draining those patients who have sterile material in their peritoneal cavities. The significance of a lower mortality rate (22.3 per cent) in the past year at the Cook County Hospital is due to the fact that the majority of patients, namely, 57 of the 76 cases, were operated upon in the first 12 hours after perforation, and in no patient operated upon was there a drain introduced into the peritoneal cavity.

#### CONCLUSIONS

1. Certain positive cultures from the peritoneal fluid in perforated peptic ulcers offer a prognostic significance as to the clinical course.

2. Cultures taken in the first 6 hours are usually sterile but when positive offer a poor prognosis.

3. The most frequent organisms found are the *Bacillus coli* and the streptococcus.

4. When cultures are sterile the postoperative course is smooth and the mortality is low.

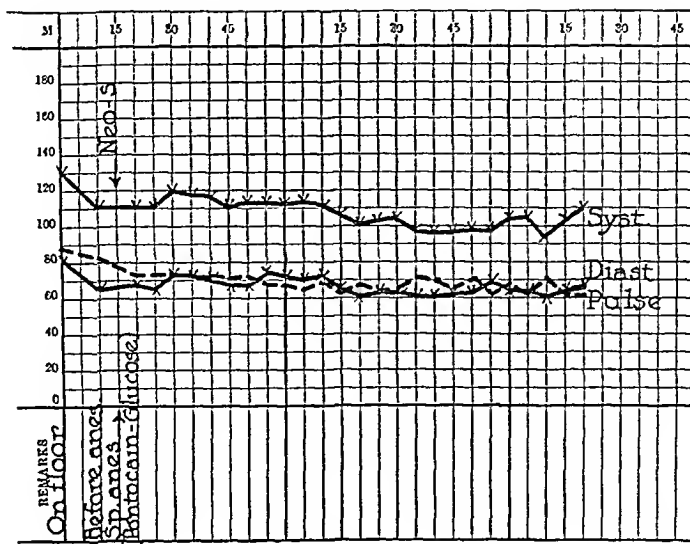
5. The presence of pathogenic organisms in the cultures is associated clinically with complications and are directly responsible for the mortality and morbidity.

6. Drainage is indicated only in patients operated upon many hours following perforation, and then this can be construed only as an heroic treatment.

We wish to thank Miss Silka Stocker and Miss Kathryn T. Buck for their technical assistance.

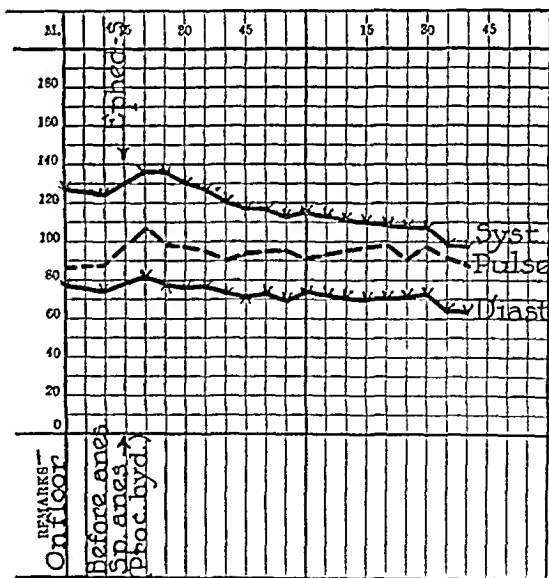
#### BIBLIOGRAPHY

1. ALEXANDER. Quoted by C. L. Gibson. *Am J M Sc* 1923 165: 500.
2. R. JETT. H. Bacteriologic considerations of erosion of perforated gastric and duodenal ulcers. *Beitr z klin Chir* 1926 138: 601.
3. CLAVEL C. and CLAVEL C. Bacteriologic des épanchements péritoneaux des ulcères gastro duodénaux perforés. *Lyon chir* 1933 30: 254-253.
4. L. S. DODGEON. MAYBURY B. C. The bacteriology of the peritoneal cavity in cases of perforation of the stomach and duodenum. *Lancet* 1915 2: 379-81.
5. FLEMMING B. L. Acute perforation of duodenal ulcers causes of death and a consideration of treatment. *J Am M Ass* 1931 97: 6-11.
6. JOURNE S. S. Statistique de 116 cas d'ulcères perforés de l'estomac et du duodénum. *J de chir* 1931 28: 159.
7. LORR W. Etiologic significance of anaerobic bacteria in perforating peritonitis complicating gastric and duodenal ulcer. *Deutsche Ztschr f Chir* 1929 214: 103-134.
8. MORTIMAN B. *Abdominal Operations* Vol 1 p 139 Philadelphia W. B. Saunders 1926.
9. ULRICH P. De la gastro pyloréctomie et de la duodéno pyloréctomie immédiates dans le traitement d'ulcères perforés de l'estomac et du duodénum. *Rev de chir* 1931 41: 46.
10. VANDER D. Contribution to our knowledge of the bacteriology of peritonitis due to ulcer. *Inaugural Dissertation* Jena 1923.

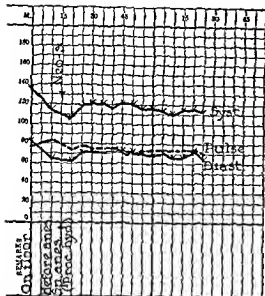


Graph 4 Average curves of blood pressure and pulse in 50 cases under high spinal anesthesia using neosynephrine with pontocaine in 10 per cent glucose solution. The average duration of anesthesia was 2 hours and 15 minutes. The stability of the curves is impressive after the use of neosynephrine.

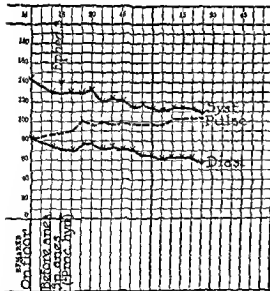
heart rate. Neosynephrine was given in doses of 0.5 cubic centimeter of a 1 per cent solution, in 15 cases it was repeated again and in 1 case 3 injections were given. It will be noted that the average systolic pressures did not vary over 12 points and the average diastolic pressures over 10 points. The average pulse rate was maintained below 80 but not lower than 70 beats a minute. One would get a false impression, however, by looking at only the average curves in regard to marked fluctuations of blood pressure under spinal anesthesia and the ability of neosynephrine to control them. In Graph 2 one can see the marked pressor response to the first dose of neosynephrine which, however, wore off in 30 minutes when the pulse pressure became small. The small pulse pressure is often the earliest sign of shock, but a small dose (0.25 cubic centimeter) of neosynephrine promptly restored the systolic blood pressure. Note also the marked bradycardia, the pulse rate ranging around 50 for at least 45 minutes. In such cases added to the hypotensive effect of the spinal anesthesia, one has to consider the effect of hemorrhage and shock, both of which may be compensated within limits by vasoconstriction (3).



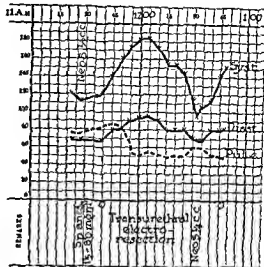
Graph 5 Average curves of blood pressure and pulse in 50 cases under high spinal anesthesia using ephedrine with procaine hydrochloride. The average duration of anesthesia was 1 hour and 40 minutes. Both systolic and diastolic pressure gradually drop. The pulse rate is well stabilized. Since these records were obtained several years ago before pontocaine-glucose was available, they are not ideal as controls to compare with Graph 4. However, pontocaine-glucose produces a long anesthesia and thus constitutes a more severe test for neosynephrine.



Graph 1. Average curves of systolic and diastolic blood pressures and pulse rates in 213 cases under low spinal anesthesia with procaine hydrochloride. Five tenths cubic centimeter of 1 per cent solution of neosynephrine was given subcutaneously 5 minutes before the intraspinal injection. The level of all 3 curves is well maintained.



Graph 2. Average curves of blood pressure and pulse in 50 cases under low spinal anesthesia. Every effort was made to make this control series comparable to the one shown on the first graph. Three fourths grain of ephedrine was used instead of neosynephrine. Note that the blood pressure shows a gradual fall and the pulse rate rises.

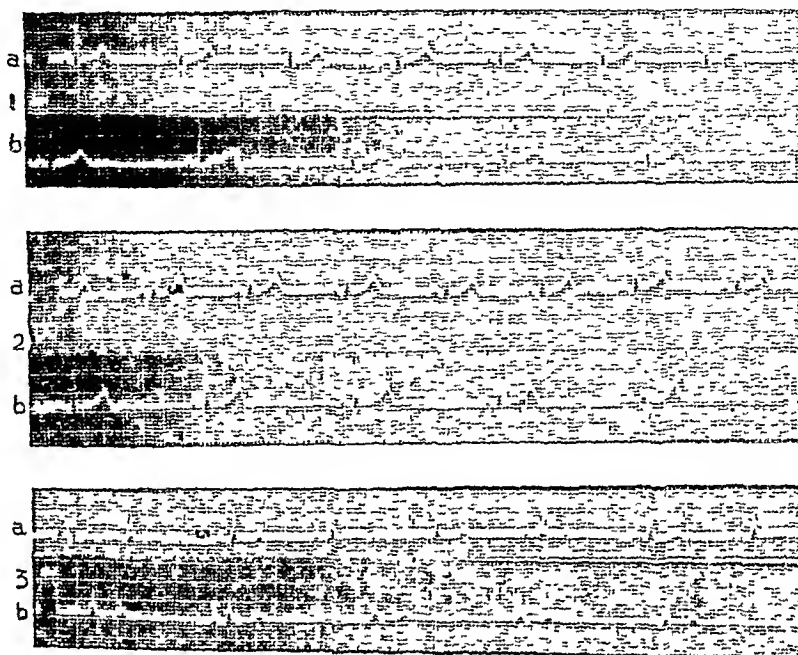


Graph 3. Blood pressure and pulse record of a patient undergoing transurethral resection of the prostate. Circles indicate beginning and end of operation. Note the marked rise in systolic with the moderate rise in diastolic blood pressures together with a slowing of the pulse after injection of one half cubic centimeter neosynephrine. A second dose of a small amount of neosynephrine (0.4-cubic cubic centimeter) is quite effective. Such large responses are sometimes seen; the pressor response here lasted 45 minutes.

our statistics were patients who had complications during operation such as hemorrhage in the presence of marked hypertension, neosynephrine was not administered except when a fall in blood pressure occurred. In order to stabilize blood pressure as much as possible a second dose of neosynephrine was given as soon as the blood pressure began to drop. The interval between 2 injections ranged from 10 minutes to 1 hour and 15 minutes, the majority of them being within 30 minutes after the first dose.

#### RESULTS

In the first group of 113 cases in which low spinal anesthesia was induced and neosynephrine was used to control the blood pressure, the average dose of procaine crystals was 97 milligrams in 2 cubic centimeters of spinal fluid. The maximum dose was 200 milligrams in 3.5 cubic centimeters and the minimum dose was 50 milligrams in 2 cubic centimeters of spinal fluid. Graph 1 shows the average systolic and diastolic blood pressures and the



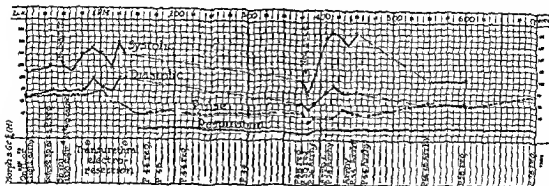
Graph 9 Electrocardiogram (a, before injection, b, after) of a patient with a normal cardiovascular apparatus before and after the administration of 1 cubic centimeter of a 1 per cent solution of neosynephrine. The pulse rate dropped to 40 from 58, a simple bradycardia resulted from the injection

the level of the umbilicus or below it, the average dose of procaine was higher than in the first group, namely, 125 milligrams. The maximum dose, however, was lower, only 150 milligrams and the minimum dose given was 80 milligrams of crystalline procaine. Ephedrine sulphate was administered in a dose of 50 milligrams (three-fourths grain). It was repeated in 2 cases. Both systolic and diastolic pressures show a gradual fall, 22 points in the systolic and 20 points in the diastolic average pressures (Graph 3). The average pulse rate in contrast to the first series shows a definite rise; it ranged between 95 and 105 beats a minute during the course of operation.

In another series of 50 patients, high spinal anesthetics were studied with neosynephrine and compared with another 50 cases in which ephedrine was employed. These 2 groups are again not strictly comparable, as in the neosynephrine group pontocaine in 10 per cent glucose was the spinal anesthetic, whereas in the control group, which was selected from the material of previous years, crystalline

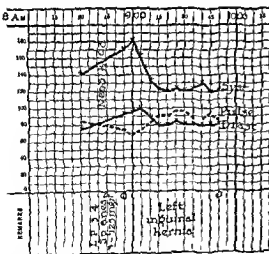
procaine was used. However, the level of anesthesia was just as high in the control series and it is permissible to assume that the fall in blood pressure is commensurate with the level of vasoconstrictor paralysis. In addition, the pontocaine-glucose anesthesia lasts so much longer than the procaine anesthesia that neosynephrine has been put to a more severe test in this group than it has been in the controls.

Graph 4 shows the average figures of 50 cases. The average dose of pontocaine was 17 milligrams, individual doses ranging from 20 milligrams in 3.5 cubic centimeters to 10 milligrams in 1 cubic centimeter of 10 per cent glucose. Readings were continued for 2 hours and 5 minutes, although individual cases had even longer operations under effective anesthesia. The curves show a satisfactory leveling of blood pressures and pulse rates within this period. Again the average pulse did not go above 73 nor drop below 60 beats per minute. The lowest average reading of blood pressure was 92/60.



Graph 6 Blood pressures and pulse rates of a patient during and for 5 hours after spinal anesthesia. Following the return of the patient to bed a bradycardia between 44 and 48 continued for over 2 hours. The pulse however was regular. When the blood pressure fell to 75/50 another 0.5 cubic centimeter of neosynephrine was given

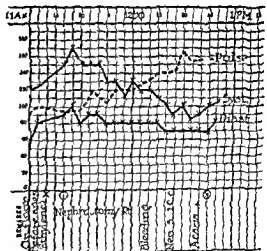
The rise in blood pressure occurred on the average within 10 minutes following the injection of neosynephrine. Within this limit 27 per cent of the cases showed a rise of 20 points or more of the systolic blood pressure while in some cases no rise occurred after the first dose. The lack of rise of course, does not indicate that the drug was ineffective, as it is really given to prevent a fall which so often accompanies spinal anesthesia.



Graph 7 This patient shows a good pressor response with a slight bradycardia which seems to last just as long as the hypertension. Such observations may be duplicated many times and would suggest that the bradycardia is a reflex response to the rise in blood pressure such as occurs when closing an arteriovenous fistula (Branham's sign)

which resulted in a prompt pressor response the pulse fell as low as 30 and later varied between 38 and 60 beats per minute. There was an arrhythmia for 2 hours. While no electrocardiogram is available during this bradycardia with arrhythmia the probability of a partial heart block is high.

A control series of 50 patients had been given a low spinal anesthesia with ephedrine as the vasomotor stimulant. While every attempt was made to select a comparable series this is possible only within limits. Thus, while all these patients had an anesthesia at



Graph 8 This patient underwent a nephro tomy under general anesthesia. Severe bleeding occurred followed by a fall in blood pressure to 90/60. The pulse rose from an initial rate of 90 to 140. One cubic centimeter of neosynephrine fell to raise the blood pressure although it might have prevented a further fall and the pulse rate rose to 160. Restoration of blood volume with serum raised the blood pressure slightly. This graph is presented to illustrate that when hypotension is due to loss of circulating blood volume the drug is not as dependable as when a pure vasomotor palsy is present.

pulse rate became as low as 30 beats per minute and a marked arrhythmia developed and persisted for 2 hours. It is interesting to note that this patient had an arrhythmia on the floor before coming to the operating room. To illustrate, however, that this bradycardia is not always of as long duration, we show the curves obtained in a patient with an inguinal hernia (Graph 7). In this case the bradycardia, which was not pronounced, lasted exactly the length of time which the hypertension did. In case of profuse hemorrhage, however, neosynephrine may not raise blood pressure or produce a bradycardia. In Graph 8 a nephrostomy was done under general anesthesia. When severe bleeding occurred and the blood pressure fell, neosynephrine did not produce a rise although it may have prevented a further fall, the pulse kept climbing up. Restoration of blood volume with acacia effected a prompt rise in blood pressure.

#### EVALUATION OF STUDY

Our experience with neosynephrine, as shown in the graphs presented, shows that it is capable of stabilizing blood pressure in spinal anesthesia in the majority of cases whether the anesthesia is low or high, or of short or long duration. As the acute hypotension during spinal anesthesia is of vasomotor origin, it is to be expected that a drug which has a marked peripheral vasoconstrictor action would be suitable for the maintenance of blood pressure. It definitely lacks the action of epinephrine and ephedrine on the central nervous system and does not increase the irritability of the patients who are in a conscious state under spinal anesthesia.

It can also be said that if the hypotension is due only to a vasomotor palsy but not to a sudden loss of circulating blood volume the drug can be depended on to restore blood pressure to a safe level. As a matter of fact the drug should really be given more for prevention of hypotension than for restoration of the blood pressure. It has been our custom to give the first dose just before the induction of spinal anesthesia and give the second dose when the blood pressure begins to drop, which is usually around 30 minutes following the induction of the spinal anesthetic.

Beside the hypertensive action of the drug a slowing of the heart occurred to 48 beats or below in 11 per cent of 163 cases. One might at first consider this as due to the pressor-receptors in the vascular system which respond with a vagal slowing of the heart whenever systemic or pulmonary pressure rises. This is a useful mechanism and has a sparing action on the heart. But as shown in Graph 6 the bradycardia outlasted the hypertension for several hours. The pulse rate dropped as low as 30 and varied mostly between 48 and 42. This and a few other observations prompted us to investigate this bradycardia more closely. Johnson has pointed out that this is a simple bradycardia and we found this to be so in a few experiments in which electrocardiographic tracings have been made before and after the use of the drug (Graph 9). That one can produce a partial heart block with neosynephrine is illustrated in the case of E. S., a patient with an atypical hyperthyroidism and a high unstable vegetative nervous system, whose electrocardiographic record would indicate that a partial heart block had been produced with 1 cubic centimeter of 1 per cent neosynephrine (Graph 10). This observation and the one recorded on Graph 6 would indicate (1) that, in patients with advanced age and slow pulse or evidence of myocardial damage, the drug be used with great caution, preferably with atropine, (2) that doses of 0.5 cubic centimeter be not exceeded for 1 injection, but repeated injections are permissible. However, we do not wish to create the impression that any untoward cardiac symptoms are to be expected from 0.5 cubic centimeter doses. To illustrate the tolerance of some patients to this drug the case of a patient who received 1 cubic centimeter of a 1 per cent solution of neosynephrine intravenously by mistake may be cited. Outside of a violent headache and palpitation no damage resulted from this error.

A further study of neosynephrine on the heart with electrocardiograms and measurements of cardiac output is now under way. As a persistent heart rate at rest below 50 is always suspicious of a heart block (4), we intend to exclude such patients from the use of neosynephrine until more is known about



# KNEE JOINT TUBERCULOSIS

## Two Hundred Twenty-Two Patients Treated by Operative Fusion

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**F**USION of the knee joint has not yet been universally accepted, especially the use of this procedure in children. It is, therefore, considered advisable to present this large series consisting of all the cases of knee joint tuberculosis operated upon at the New York Orthopedic Hospital from September, 1915, through December, 1936. Knee fusion was performed in 222 cases during this period. One hundred and ninety-nine cases have been followed 1 year or more, and these patients form the group for end-result study.

### DIAGNOSIS

The diagnosis is not difficult in late cases which often have a suggestive appearance. Flexion deformity, synovial thickening, marked atrophy of the thigh and calf, with slight heat and tenderness at the joint, form a typical group of physical signs to which sinus formation is frequently added. In the early cases, the diagnosis is not so evident. Persistent, unilateral, synovial thickening or effusion at the knee, raises the question of tuberculosis, and it has been our experience at this hospital for many years that this question cannot be satisfactorily answered except by exploration of the joint, thereby verifying the diagnosis by laboratory methods. Tuberculosis may be present even though it is not found by aspiration and guinea pig inoculation.

The most usual history is one of chronic swelling of the knee with gradual onset. A history of injury was given in 60 of the entire series of 222 cases. It is difficult to evaluate this factor. Frequently trauma is slight and the symptoms do not appear until many months after the injury.

In 146 cases of the series the diagnosis was proved by the finding of tubercles in the sections of pathological material taken from the knee joint, by guinea pig inoculation of this

material, or by both. Thirty-two cases were negative. It is our practice to take from each joint opened, tissue for frozen sections, tissue for permanent sections, and tissue and joint fluid for culture. We advocate the inoculation of 2 guinea pigs in each case, as we have found that a number of pigs died of causes other than tuberculosis before the allotted 3 weeks prior to autopsy. The 32 unproved cases were included in the series because of the history, physical, and operative findings. It is sometimes difficult for the surgeon to select fragments of tissue which contain tubercles for examination, even when the process is active and extensive. Tubercles are more frequently found in the synovial layer than elsewhere in the joint. Many of the unproved cases are those of long duration in which patients have had years of conservative treatment prior to operation. Their course has been typical of tuberculosis, the majority having had sinuses in the past. At operation, there is found much fibrosis, marked destruction of cartilage, and usually erosion of bone.

### SYMPTOMS AND SIGNS IN EARLY CASES

Seventy-nine cases entered the clinic for treatment 1 year or less following the onset of symptoms and form an interesting group of early cases. The most common presenting complaint among these individuals was swelling at the knee, the next was pain, and the next, stiffness. A limp, though it must have been present early, was not noted as a rule. The shortest period in which medical aid had been sought after the onset was 3 days.

In the dispensary examination of these early patients, physical signs were noted in the following frequency: swelling, 67; flexion deformity, 43; spasm, 37; effusion, 30; increased heat, 19; atrophy, 12; tenderness, 9; sinuses, 3. In every case one or more definite physical signs were present. In all these early cases the legs were of equal length.



the action of this drug on the heart. While a pre operative electrocardiogram often would be desirable, its routine use on large surgical services is not feasible at present, nor is the clinical significance of some abnormal electrocardiographic findings certain enough to deny some of these patients the benefit of surgical relief. This is especially true of the group suffering from prostatic obstruction.

#### SUMMARY AND CONCLUSIONS

In a series of 163 patients who were given a spinal anesthesia neosynephrine was used in a single or repeated dose to stabilize blood pressure. In a control series of 100 patients ephedrine was employed for the same purpose. It was found that neosynephrine could be depended upon to raise or maintain a falling blood pressure at least as effectively as ephedrine but it lacked the stimulating effect of ephedrine on the central nervous system which is a distinct advantage. Also instead of producing a tachycardia, as epinephrine and

ephedrine do, a bradycardia was quite apparent. The finding of this bradycardia has led to a warning in patients suffering from myocardial damage and especially those in whom partial heart block is suspected. In the group, however, which contained many bad risks no untoward reactions have been produced.

#### BIBLIOGRAPHY

1. BRUNNER R. The use of neosynephrine in spinal anesthesia. Presented at the clinical meeting of the American College of Surgeons Chicago October 1937.
2. JOHNSON C A. A study of neosynephrine hydrochloride in the treatment of acute shock from trauma or hemorrhage. *Surg. Gynec. & Obst.* 1936 63 35.
3. Idem. Neosynephrine hydrochloride in the treatment of hypotension and shock from trauma and hemorrhage. *Surg. Gynec. & Obst.* 1937 65 458.
4. LEWIS T. Diseases of the Heart. New York: The Macmillan Company 1936.
5. LORHAN P H and GUERIN R M. A study of the use of neosynephrine hydrochloride in spinal anesthesia in place of ephedrine for the sustaining of blood pressure. *Anes. & Anal.* 1938 17 44-48.
6. TOVELL R H. Control of blood pressure during spinal anesthesia. *Proc. Staff Meet. Mayo Clin.* 1936 11 53.



yses was often present. There was x-ray evidence of bone erosion in 5 cases.

In later stages progressive thinning of cartilage, bone erosion, and a transparent haziness of the bone shadow make the roentgenographic diagnosis less difficult. The most usual conditions to be confused with early tuberculosis are gonococcus arthritis, and arthritis of the rheumatoid type. Early acute suppurative arthritis may also give the x-ray appearance of tuberculosis though clinical differentiation should be easy.

#### PRE-OPERATIVE EXAMINATION

In this series there were 130 males and 92 females. The ages at the onset of symptoms were distributed from 6 months to 61 years and were grouped as shown in Table I.

TABLE I — AGE AT ONSET

Age in years	No. of cases
Under 10	127
10-19	44
20-29	27
30 and over	25

The ages at the time of fusion varied from 2½ to 62 years, and were grouped correspondingly as in Table II.

TABLE II — AGES AT TIME OF FUSION

Age in years	No. of cases
Under 10	60
10-19	73
20-29	43
30 and over	47

The usual findings before operation were swelling, limitation of motion, spasm, and atrophy of the thigh and calf. Increased heat and effusion were less commonly present. In several instances an effusion was noted which was found to consist of greatly thickened, soft, boggy, synovial lining at operation.

Measurements before fusion were recorded in 153 cases. There was shortening of the affected extremity in 62 cases, lengthening in 30 cases, and the legs were of equal length in 61 cases. Shortening was present up to 3 inches. The median was 1 inch. In the cases with lengthening of the involved extremity the maximum was 1 inch and the median one-half inch.

The position of maximum extension was noted in the pre-operative examination of 180 patients. The most severe flexion deformity was 55 degrees and the average was 20 degrees. In 21 cases complete extension was present.

Actively draining sinuses were present at the time of the fusion operation in 15 cases. In 25 other cases actively draining sinuses previously present had healed at the time of operation.

A record of tonsil examination was made in 159 cases. The tonsils appeared negative in 74 cases and inflamed or hypertrophied in 41 cases. In 41 additional cases tonsillectomy was done before operation and soon after fusion in 3 cases. Microscopic sections of tonsil tissue were examined in 15 of these cases. In 5 patients tuberculosis was found and in the 10 remaining the reactions were negative. In our opinion tonsils which do not appear normal should be removed before the fusion operation, thereby eliminating a possible focus of tuberculosis.

At examination before operation physical signs of active pulmonary tuberculosis were present in 14 cases and there were signs of inactive pulmonary tuberculosis in 4 cases. Fifty-one chest roentgenograms were taken before operation. Evidences of active pulmonary or hilus tuberculosis were present in 21, 10 had healed lesions, and 20 were negative. Other complications noted before operation are as follows:

TABLE III — COMPLICATIONS

Complication	No. of cases
Tuberculosis of hip	5
Tuberculosis of spine	9
Tuberculosis of ankle	2
Tuberculosis of wrist	1
Tuberculosis of tarsus	1
Multiple soft tissue tuberculous abscesses	1
Tuberculous cervical adenitis	1
Tuberculosis of kidney	3
Tuberculosis of sternum	1
Tuberculosis of testes	1
Syphilis	4
Gonorrhea	1

#### DECLINING INCIDENCE

The most encouraging aspect of knee joint tuberculosis, apart from the success of arthrodesis, is its declining incidence. This is also

### PRE-OPERATIVE TREATMENT

Many of the patients in this series had been treated conservatively for years. In the entire series the average duration of symptoms before operation was  $6\frac{1}{2}$  years, and there were 18 patients who had had symptoms for 15 to 48 years. There were 24 patients who were treated conservatively at the Country Branch of the New York Orthopedic Hospital at White Plains, New York, for a period of from 1 to 10 years (median 4 years), and in addition, 31 patients who had been under our treatment at the dispensary from 1 to 19 years (median 5 years). This forms a group of 54 cases, in which certainly a fair trial of conservative treatment had been made and yet the condition was not arrested by this treatment, or else, there was finally presented an inactive joint so deformed by disease that it was unfit for weight bearing. How much better it would have been had these patients with distorted useless joints come to operative fusion early instead of undergoing long years of disability meanwhile harboring a potentially dangerous focus of tuberculosis. At the Country Branch Hospital every effort was made to improve the general health of these patients. They were treated by rest and plaster when the condition was acute and in the chronic stage walking with a brace was allowed. A long leg brace was used with a steel upright on either side and leather backing behind the knee, and in some cases behind the entire leg which was snugly bandaged against the leather. The brace was attached to the shoe or to an inner foot plate and lateral joints permitted ankle motion.

It has become our practice to explore the knee by operation as soon as the diagnosis of tuberculosis is suspected either to rule out that disease by laboratory examination or to fuse the joint if the frozen section is positive. These cases are unselected except for a few in which fusion was not performed because the patient's condition obviously did not warrant the operation.

### LABORATORY DIAGNOSIS

It cannot be said that frozen section is entirely reliable as there were 3 cases in which the frozen section was negative whereas the

additional permanent sections were positive thus necessitating arthrodesis at a second procedure. In 11 cases the sections were positive while the guinea pig inoculated with material from the same knee at the same time, was negative. In 2 cases the sections were negative while reaction in the pig was positive for tuberculosis. In 2 instances an inoculated pig developed tuberculosis, while a second pig inoculated with the same material from the same knee was negative.

A Mantoux or von Pirquet test was reported in 154 cases. In 2 of these cases the von Pirquet test was negative. One case was proved by section and pig while the sections in the other case, which was a chronic one of long duration were negative.

In 116 cases white blood and differential counts were taken shortly before fusion. In half the cases, which were children under 12 years of age, the lowest white count was 3,500 the highest 14,000 and the average 9,000. The other half were patients over 12 years old and among them the lowest white count was 4,600 the highest 17,000 and the average 9,500. In the younger group the polymorphonuclear leucocytes ranged from 15 to 83 per cent, the average 52 per cent. In the older group this varied from 44 to 87 per cent with an average of 69 per cent.

A Wassermann Kahn or Klein test was done on the blood of 146 patients. Four had plus 4 Wassermann reactions. Fusion occurred in all 4 syphilitic cases in from 8 to 17 months after operation.

Red blood counts and hemoglobin determinations were made in 93 cases before fusion. The lowest red count was 1,300,000 the highest 3,900,000 and the average 4,500,000. The percentage of hemoglobin varied from 50 to 100 per cent and the average was 77 per cent.

### X-RAY FINDINGS

Forty three cases had x-ray films taken 1 year or less after the onset of symptoms and these form a group for the study of early x-ray changes in this condition. The most common finding was effusion or synovial thickening which was seen in 31 instances. Thin joint space and decalcification were each present in 18 cases and overdevelopment of the epiph-

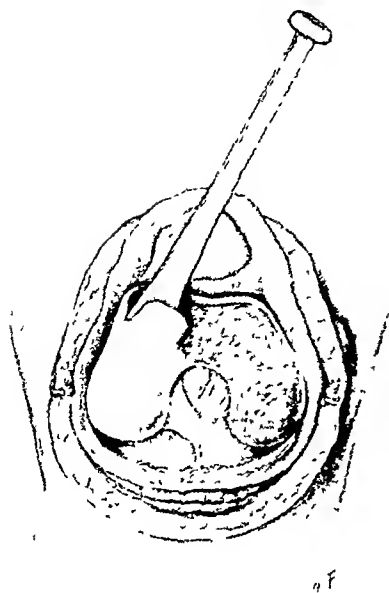


Fig 2 Removal of articular cartilage from femur

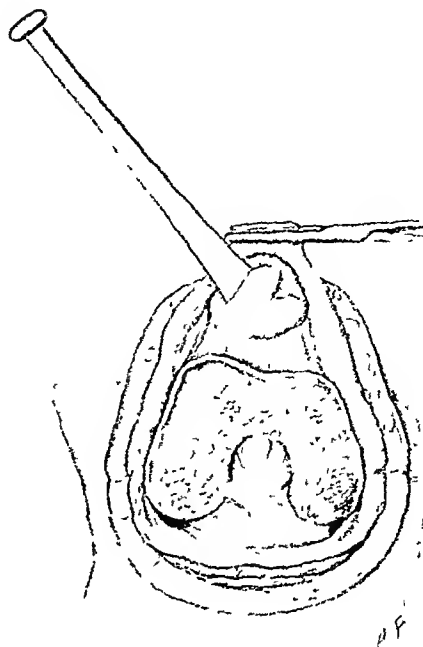


Fig 3 Removal of articular cartilage from patella

costal margin. Adult knees are put up in 10 degrees' flexion as the gait is better in that position, while those of children are placed in 180 degrees' extension to prevent strain on the lower femoral epiphysis

Since 1928 ethylene has been the routine anesthetic for these cases, previously gas-ether was used. Ethylene has been employed

in 58 cases, gas-ether in 161, and spinal in 3. In no case has pulmonary tuberculosis flared up after operation whether gas-ether or ethylene was employed. A tourniquet is used during operation, the leg being first emptied of blood by a spiral Esmarch rubber bandage

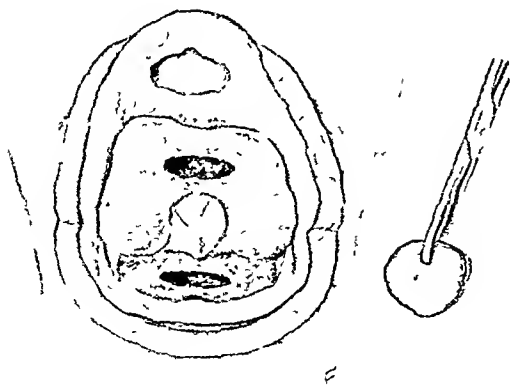


Fig 4 Patella has been enucleated, and tibial articular cartilage has been removed. Slots have been made in femur and tibia to receive patella

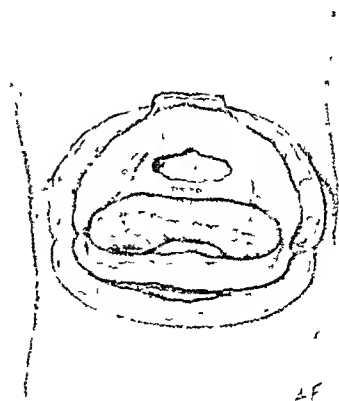


Fig 5 Patella has been placed in prepared slots

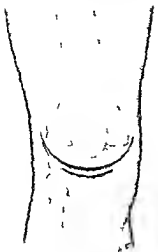


Fig. 1. Incision for arthrodesis of knee joint

true of the general incidence of joint tuberculosis. In the 5 year period 1921 through 1925, an average of 15 knee fusions for tuberculosis were performed at this hospital each year. In comparison, during the 5 year period 1932 through 1936, the yearly average was but 5 knee fusion cases.

#### OPERATION ON KNEE PREVIOUS TO FUSION

Aspiration for diagnosis was done at this hospital on 16 knees and the fluid was used for guinea pig inoculation. The pigs were positive in 8 cases and negative in 8. Six of the 8 cases with negative aspirations were proved tuberculous at subsequent operation. A negative aspiration therefore does not rule out tuberculosis and this procedure should be reserved for cases in which operation must be delayed.

Exploratory arthrotomy was performed in 17 cases previous to fusion and the diagnosis of tuberculosis was verified by laboratory findings. In 4 other cases synovectomy was done because the frozen section was negative though the final report on the permanent sections was positive for tuberculosis. Three additional synovectomies were done with a pre-operative diagnosis of chronic arthritis the final sections proving the condition to be tuberculosis. Incision and drainage and synovectomy were performed in 4 secondarily in-

fect cases, and 2 cases had a tuberculous bone abscess close to the joint which was explored before fusion.

Twenty four additional operations were performed at other hospitals on 19 patients before fusion. These procedures included arthrotomy, resection synovectomy, incision and drainage, excision of meniscus, aspiration, and attempted arthrodesis.

#### FUSION OPERATION

Arthrodesis was performed in all cases essentially in the manner described by Russell A. Hibbs in 1911, who first used this procedure in cases of poliomyelitis. According to the present technique, the knee is widely exposed through a U shaped incision, from the medial aspect of the joint at the femoral condyle curving to bisect the ligamentum patellae to a corresponding point on the lateral aspect of the joint. The medial limb of the U is made first and the joint exposed through it for *trozer* section. The menisci are removed together with the articular cartilage from the femur and tibia to secure direct bone contact between them. The patella is denuded of cartilage and periosteum and it is placed in the slots prepared for it without changing its axis. In some cases a portion of the periosteum on the anterior surface of the patella is left attached.

Formerly the wound was closed with chromic suture for the skin though recently silk has been used in preference. In 2 cases the patella was diseased so extensively that it could not be employed in the mortice and in 2 children the bony portion of the patella consisted of a very minute fragment. In 7 cases the patella was found to be formed entirely of cartilage and in 2 of the cases the patella could not be used. In 5 cases the wound was drained because of secondary infection from open sinus tracts. The operations in this series were performed by 30 different surgeons.

Once the closure has been completed a dry dressing is placed on the wound. The joint is then surrounded with a layer of cotton, care being taken to protect the peroneal nerve at the fibular head. Short wadding and paper are applied and then the single plaster spica extending from the toes to above the lower

material may become abundant in the joint. Thinning of the cartilage to the extent of perforation is a later change. The cartilage seems more resistant than the bone to destruction, as not uncommonly a small perforation through the cartilage becomes the mouth of a large cavity in the bone beneath. However, in 3 cases in the entire series the joint unquestionably became involved secondarily by direct extension from a tuberculous bone abscess. Areas of caseation are found only in advanced cases.

#### POSTOPERATIVE CARE

Two weeks after operation the plaster is fenestrated over the operative wound for inspection and suture removal. The case is then transferred by ambulance to the Country Branch Hospital at White Plains for convalescent care. Eight weeks after the fusion operation the spica is removed, an x-ray is taken, and a long leg plaster is applied from toes to groin in which the patient is allowed to walk. Following this the plaster is changed at 8 week intervals with an x-ray examination after each removal until the fusion is solid. Then the cast is left off and the patient is allowed to walk without protection. Children, however, at this stage are given a long leg brace to prevent slipping of the lower femoral epiphysis. Twenty-eight children wore braces after the plaster was removed for an average period of 8 months. Experience has shown that in some cases slipping of the lower femoral epiphysis has occurred which probably could have been prevented by the use of a brace. Epiphyseal slipping, a troublesome postoperative complication, occurred after operation in only 3 children over 10, and in each instance this was because the knee was not put up straight at the time of operation.

#### OCCURRENCE OF FUSION

Cases have been kept in plaster from 2 to 42 months postoperatively. The average time was 8 months. The plaster is left on in most cases until the arthrodesis is solid. Therefore, this is a measure of the time elapsed in securing fusion. A few cases with extremely active disease and many sinuses have been kept in bed longer than the 8 weeks' routine period of bed rest before weight bearing was allowed.

#### END-RESULTS

Of the 222 cases in which the knee fusion operation was performed, 5 died within 1 year after operation, and 18 patients were lost to the follow-up clinic within a year.

One hundred and ninety-nine cases thus remained which were followed for more than 1 year after operation and these form the group for end-result study. Every one of these 199 knees in the end-result group fused but 3; and these 3 had such hopeless sinuses both before and after the fusion operation that amputation of the leg was finally performed. These 3 patients were living and well at the last examination.

No patient with a follow-up period shorter than 1 year was retained in this series. The longest follow-up period after fusion was 17 years, the average  $5\frac{1}{2}$  years. These end-result examinations were made by the staff of the New York Orthopedic Hospital.

Seven of the 199 patients, followed for more than 1 year, are dead, and successful fusion had taken place in each case. (The diagnoses at the time of death in these 7 cases were the following: pneumonia, carcinoma of the uterus, amyloidosis, pulmonary tuberculosis, renal tuberculosis, sarcoma, and unknown in 1 case.)

In the 196 cases which became fused, there was no evidence of either tuberculosis or secondary pyogenic infection remaining at the knee, except in 7 patients who had draining sinuses at the last examination. There are 3 cases now fused in which a refusion operation was performed.

The position in which the knee was arthrodesed at last examination was noted in 142 cases. Eighty-three of these were flexed, 49 were straight, and 10 were in recurvatum. In the flexed group the median amount was 10 degrees, and in the hyperextended cases the median was 10 degrees. Knock knee was present in 19 and the median was 5 degrees. Two cases had a genu varum deformity. Four cases were advised to have osteotomy because of the degree of flexion deformity.

In 93 cases measurements from the anterior superior iliac spine to the medial malleolus were recorded and 76 of these had shortening. The greatest amount of shortening was 5

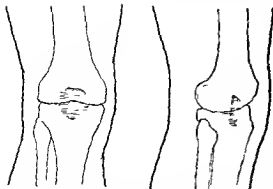


Fig 6 Position of patella when arthrodesis has been completed. Bony contact has been secured between femur and tibia.

Five cases died within 1 year after operation. Three of these died of tuberculous meningitis, 1 of pulmonary tuberculosis, and 1 of renal tuberculosis.

#### PATHOLOGICAL FINDINGS

Thirty four patients were operated upon at the New York Orthopedic Hospital within 1

year after onset of symptoms and in 32 of these tuberculosis was proved by sections or inoculation of pigs. These cases were significant because of the early pathological changes. According to the operative findings, the synovial layer was involved in all these cases and was found to be thickened in 30 cases. The synovial membrane was red or gray in color, and in 7 cases was described as 'gelatinous'. An excess of turbid fluid was present in 5 cases and a serous effusion in 6. Three joints contained thick pus. The cartilage was eroded in 15 cases and usually was partially covered with pannus before erosion. Bone destruction was present in 7 cases. In every case but 1 it appeared that the synovial layer was the primary site of the disease.

Thus in the earliest cases a moderate thickening and reddening of the synovial layer are all that is seen. There may or may not be a serous effusion. In these cases there is often pannus formation on the joint cartilage where it does not directly articulate. Later this may extend over the articular portions. As the synovial lining becomes more necrotic the color changes to gray and its appearance has been described frequently by surgeons as "edematous." This edematous or gelatinous



Fig 7 W. J. Proved tuberculosis of knee joint. Fusion was performed at age of 5-6 years before this roentgenogram was taken.



Fig 8 J. F. Proved tuberculosis of knee joint. Fusion was performed at age of 12 years, 1 year before this roentgenogram was taken.

CASE E. M. No. 127438, male Fusion operation was performed at the age of 4 years when tuberculosis was proved. Symptoms had been present for less than 1 year. The last examination took place 8 years after fusion. The knee was solidly fused with 20 degrees' flexion and  $1\frac{3}{4}$  inches' shortening.

CASE E. D. No. 131477, female Fusion operation at the age of 4 years proved tuberculosis. Symptoms were present for  $1\frac{1}{2}$  years. The last examination took place 6 years after operation at which time shortening was  $1\frac{3}{4}$  inches because the lower femoral epiphysis was implicated by disease.

CASE W. J. No. 141612, male Fusion operation at the age of 5 years proved tuberculosis. Symptoms were present for 1 year. Seven years after operation the knee was fused in straight alignment with  $1\frac{1}{4}$  inches of shortening.

CASE B. R. No. 143464, female Fusion operation at the age of 2 years (the youngest case in the entire series) proved tuberculosis. Symptoms were present for 6 months. The patient was last seen 6 years after operation with the knee fused in 5 degrees' flexion and shortened  $\frac{1}{2}$  inch.

CASE H. B. No. 152587, male Fusion operation at the age of 4 years proved tuberculosis. Symptoms were present for  $1\frac{1}{2}$  years. The patient was last seen 2 years after operation with  $\frac{3}{4}$  inch shortening. Fusion took place in full extension with slight knock knee.

CASE R. S. No. 184967, male Fusion operation at the age of 5 years proved tuberculosis. Symptoms were present 7 months. The knee was solidly fused in straight alignment with  $\frac{3}{4}$  inch shortening  $2\frac{1}{2}$  years after fusion. The lower femoral epiphyseal line had been destroyed by cavitation before operation.

#### SUMMARY AND CONCLUSIONS

1. In the period, September, 1915, to December, 1936, knee fusion was performed in 222 cases of knee joint tuberculosis at the New York Orthopedic Dispensary and Hospital.

2. One hundred and ninety-nine of these cases have been followed from 1 to 17 years after operation with an average follow-up period of  $5\frac{1}{2}$  years.

3. Fusion occurred in 196, or 98 per cent, of these cases. Fusion took place and plaster was left off at an average period of 8 months after operation. The disease subsided in all but 7 in whom sinuses persisted. In no fused knee did tuberculosis recur.

4. Fifty-nine patients were 10 years of age or less at the time of operation, and 14 were 5 years old or less.

5. Diagnosis, operative technique, and after care are described.

6. The results of arthrodesis in very young children are discussed.

7. On the basis of our 21 year experience with operative arthrodesis of the knee joint for tuberculosis in 222 cases, this procedure is recommended both for children and for adults. In no other joint in the body has such a high percentage of successful fusions been obtained.

#### REFERENCES

- CYRIAX, J. H. A survey of treatment of tuberculosis of the knee joint. *J. Bone & Joint Surg.*, 1932, 14, 847-858.  
 GIRDLESTONE, G. R. Pathology and treatment of tuberculosis of the knee joint. *Brit. J. Surg.*, 1932, 19, 488.  
 HENDERSON, M. S., and FORTIN, H. J. Tuberculosis of the knee joint in the adult. *J. Bone & Joint Surg.*, 1927, 9, 700-713.  
 HIBBS, R. A. An operation for stiffening the knee joint. *Ann. Surg.*, 1911, 53, 404-407.  
 HIBBS, R. A., and VON LACKUM, H. L. End results in treatment of knee joint tuberculosis. *J. Am. M. Ass.*, 1925, 85, 1289-1291.



inches in a patient who had had a resection elsewhere previous to fusion. The average shortening of the 90 cases was 1 inch. In 1 case, the fused leg was one fourth inch longer than the other.

*Slipping lower femoral epiphysis.* The most troublesome postoperative complication is the tendency of the lower femoral epiphysis to slip in children up to the age of 14 after fusion has taken place. In 19 children slipping, requiring either closed or open correction, took place between the ages of 3 and 14. Closed stretching under anesthesia was done in 17 cases and repeated in 2 of them. Supracrotellar femoral osteotomy was done in 7 cases and osteotomy at the fusion site in 4. Only 1 slipping occurred at the upper tibial epiphysis. At present we believe that this slipping has been overcome by putting up the child's knee in full extension and by the use of a long leg brace in younger children.

*Wound healing.* Of 149 cases reported, 90 patients had healed wounds and no sinuses at the first plaster change 8 weeks after operation. The 50 remaining had sinus formation in wounds or other locations at that time. However, there were only 15 patients who had sinuses 1 year after fusion. There were 6 wound infections in patients who had no sinuses before operation. In 7 cases sinuses persisted when patients were last seen.

*Other complications.* Transient tourniquet paralysis was present in several cases before the adoption of the present technique, consisting of the use of an Esmarch elastic bandage to empty the leg of blood. Temporary foot drop, due to pressure of the cast against the peroneal nerve at the fibular head, was present in several cases. Only 1 patient in the entire follow up series was incapacitated by active pulmonary tuberculosis at last examination.

*Arthrodesis in very young children.* There are 14 patients in the entire series who were 5 years old or less at the time of the fusion operation, the youngest being only 2. Solid bony fusion is present in every case in this group and 6 of these patients have been followed 8 to 14 years since the time of fusion. In patients with marked shortening the epiphyseal lines close to the knee have been

implicated by disease before operation. In all early cases some shortening will result due to atrophy. As I believe this to be the only series of fusions in such young patients extant, a brief resume of each case follows.

**CASE J P No 49947, male.** Fusion operation was performed at the age of 5 years when tuberculosis was proved. Symptoms were present since the age of 1. It is now 14 years after his operation and he is 19 years old. The knee is solidly fused but he has  $4\frac{1}{2}$  inches of shortening, due to the implication of the lower femoral epiphysis by disease destruction.

**CASE E S No 82125, male.** Fusion operation was performed at the age of 3 years when tuberculosis was proved. Onset of symptoms occurred at the age of 2 years with an abscess of the femoral epiphysis which extended into the joint. It is now 12 years after fusion and patient is 15 years old. The knee is solidly fused in 10 degrees flexion and shortening measures 2 inches.

**CASE C P No 55324, male.** Fusion operation took place at the age of 3 years and case remained unproved. Symptoms were present since the age of 1 year. The last examination took place 13 years after operation. The knee was solidly fused in 5 degrees flexion. Shortening of  $3\frac{3}{4}$  inches was due to the fact that upper tibial epiphysis was partially destroyed before operation.

**CASE P W No 65539 female.** Fusion operation at the age of 5 years proved presence of tuberculosis. Symptoms had been present for 2 years. It is now 12 years since operation and patient is 17 years old. There is shortening of 2 inches and complete fusion at 180 degrees extension.

**CASE B E No 93406 female.** Fusion operation at the age of 4 years proved presence of tuberculosis. Symptoms had been present for less than 1 year. The patient was followed 3 years. The knee fused in 10 degrees flexion and the shortening measured  $1\frac{1}{2}$  inch.

**CASE W T No 99536 male.** Fusion operation at the age of 3 years proved the presence of tuberculosis. Symptoms were present for 2 years. The patient was followed 4 years. At the last examination fusion was solid in 15 degrees flexion and the legs were of equal length.

**CASE A L No 101147 male.** Fusion operation at the age of  $2\frac{1}{2}$  years proved tuberculosis. Symptoms were present over 1 year. The patient was 12 years  $3\frac{1}{2}$  years after operation when he presented solid fusion and  $2\frac{1}{4}$  inches of shortening.

**CASE J F No 11390 male.** Fusion operation was performed at the age of  $2\frac{1}{4}$  years. Onset occurred at the age of 1 year. Tuberculosis which began in abscess of upper tibial epiphysis and which involved joint secondarily was proved. The patient was last seen 8 years after fusion at which time the knee was fused in 5 degrees of flexion with 1 inch of shortening.

CASE E M No 127438, male Fusion operation was performed at the age of 4 years when tuberculosis was proved Symptoms had been present for less than 1 year The last examination took place 8 years after fusion The knee was solidly fused with 20 degrees' flexion and  $1\frac{3}{4}$  inches' shortening

CASE E D No 131477, female Fusion operation at the age of 4 years proved tuberculosis Symptoms were present for  $1\frac{1}{2}$  years The last examination took place 6 years after operation at which time shortening was  $1\frac{3}{4}$  inches because the lower femoral epiphysis was implicated by disease

CASE W J No 141612, male Fusion operation at the age of 5 years proved tuberculosis Symptoms were present for 1 year Seven years after operation the knee was fused in straight alignment with  $1\frac{1}{4}$  inches of shortening

CASE B R No 143464, female Fusion operation at the age of 2 years (the youngest case in the entire series) proved tuberculosis Symptoms were present for 6 months The patient was last seen 6 years after operation with the knee fused in 5 degrees' flexion and shortened  $\frac{1}{2}$  inch

CASE H B No 152587, male Fusion operation at the age of 4 years proved tuberculosis Symptoms were present for  $1\frac{1}{2}$  years The patient was last seen 2 years after operation with  $\frac{3}{4}$  inch shortening Fusion took place in full extension with slight knock knee.

CASE R S No 184967, male Fusion operation at the age of 5 years proved tuberculosis Symptoms were present 7 months The knee was solidly fused in straight alignment with  $\frac{3}{4}$  inch shortening  $2\frac{1}{2}$  years after fusion The lower femoral epiphyseal line had been destroyed by cavitation before operation

#### SUMMARY AND CONCLUSIONS

1 In the period, September, 1915, to December, 1936, knee fusion was performed in 222 cases of knee joint tuberculosis at the New York Orthopedic Dispensary and Hospital

2 One hundred and ninety-nine of these cases have been followed from 1 to 17 years after operation with an average follow-up period of  $5\frac{1}{2}$  years

3 Fusion occurred in 196, or 98 per cent, of these cases Fusion took place and plaster was left off at an average period of 8 months after operation The disease subsided in all but 7 in whom sinuses persisted. In no fused knee did tuberculosis recur

4 Fifty-nine patients were 10 years of age or less at the time of operation, and 14 were 5 years old or less

5. Diagnosis, operative technique, and after care are described

6. The results of arthrodesis in very young children are discussed.

7 On the basis of our 21 year experience with operative arthrodesis of the knee joint for tuberculosis in 222 cases, this procedure is recommended both for children and for adults In no other joint in the body has such a high percentage of successful fusions been obtained

#### REFERENCES

- CYRIAX, J H A survey of treatment of tuberculosis of the knee joint *J Bone & Joint Surg*, 1932, 14 847-858  
 GIRDLESTONE, G R Pathology and treatment of tuberculosis of the knee joint *Brit J Surg*, 1932, 19 488  
 HENDERSON, M S, and FORTIN, H J Tuberculosis of the knee joint in the adult *J Bone & Joint Surg*, 1927, 9 700-713  
 HIBBS, R A An operation for stiffening the knee joint *Ann Surg*, 1911, 53 404-407  
 HIBBS, R A, and VON LACKUM, H L End results in treatment of knee joint tuberculosis *J Am M Ass*, 1925, 85 1289-1291

# THE PHOSPHATASE DETERMINATION IN THE DIFFERENTIAL DIAGNOSIS OF BONE LESIONS

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THE enzyme phosphatase has been shown to be present in several tissues of the body in varying amounts, being highest under normal conditions in the intestinal mucosa, renal tissue and in tissue forming new bone (28). Its presence in the intestine is thought to be related to absorption, and in the kidney to excretion of phosphorus. The presence of phosphatase in tissue which is producing new bone is intimately associated with the process of ossification, and it has been suggested by Rohison and Soames that the enzyme is the product of young osteoblasts and hypertrophic cartilage cells. Experimental evidence has shown that its function is to hydrolyze the phosphoric esters of the body to render phosphate ions available for incorporation into the chemical structure of bone (27).

Since Rohison, in 1923, first indicated the important rôle of phosphatase in the process of ossification, much experimental effort has been expended in defining the occurrence and characteristics of the enzyme. The reports by Kay in 1929 (16) and Roberts in 1930 (25) of quantitative phosphatase determinations on the blood of patients with disturbances of bone introduced this procedure into the chemical study of bone lesions and demonstrated the phosphatase activity of the blood to be especially high in osteitis deformans. The phosphatase activity of the blood was soon examined by others in many types of bone lesions, and elevated values were found in lesions of such diverse nature as rickets, secondary carcinomatous lesions of bone, hyperparathyroidism with bone involvement, and osteogenic sarcoma.

The earlier work on phosphatase was comprehensively reviewed by Kay in 1932 (19). Besides the earlier reports by Kay and Roberts referred to, additional series of phos-

phatase determinations on the blood of patients with the bone lesions under consideration here have been reported by Kay (18), Bodansky and Jaffe, Austoni and Coggi, Franseen and McLean, Simmons and Franseen, Pautrat, Woodard, Twombly, and Coley, Gutman, Tyson, and Gutman, and Woodard and Higinbotham. The reader is referred to these publications and to the recent review of plasma phosphatase in disease by Morris and Peden for a more exhaustive bibliography. Bone lesions such as rickets, osteomalacia, osteomyelitis, and fractures, in all of which the phosphatase of the blood has been reported to be increased, have been omitted from individual consideration here, as well as conditions with a non osseous source of increased phosphatase activity of the blood, as for example, liver damage with or without jaundice.

Certain generalizations can be derived from the contributions to the study of blood phosphatase in relation to its production by the osteoblastic cells. It is clear that any abnormal osteoblastic activity is reflected as an elevated phosphatase activity of the circulating blood, roughly proportional to the extent and intensity of the attempt at ossification. The phosphatase activity of the blood has been found to be increased in such groups of bone lesions as (1) abnormal or neoplastic proliferation of bone (osteitis deformans, osteogenic sarcoma, myositis ossificans), (2) frustrated attempts at osteogenesis (rickets) with the production of osteoid tissue, and (3) reparative processes accompanying or following inflammatory traumatic or neoplastic destruction of the architecture or the continuity of bone (repair of fractures, repair of areas destroyed by osteomyelitis, or repair of areas being destroyed by carcinomatous metastases). This diversity of type among the bone lesions associated with an elevation of the

phosphatase activity of the circulating blood is also good evidence, first, that this increased activity is not specific for any particular disturbance of bone, and second, that it is the result of the disease rather than its cause. In more slowly reparative or proliferative processes (e.g. osteoma, osteochondroma), the osteoblastic activity is not intense enough to be reflected in the circulating blood. In these cases, the destruction or elimination of the phosphatase present in the circulating blood is perhaps as rapid as its production. Similarly, in purely destructive lesions as, for example, myeloma, the normal level of the phosphatase activity of the blood is at most only very slightly disturbed. This is probably due to the fact that the normal phosphatase content of adult bone is so slight that its liberation in the process of dissolution of the bone does not measurably alter the activity of the circulating blood, and furthermore, reactive osteoblastic activity is practically nil in these lesions. When destructive and reparative processes occur simultaneously, as in carcinomatous metastases in bone, the constructive process alone is reflected in the phosphatase activity of the blood serum or plasma. In tumors without bone or liver involvement the phosphatase activity of the blood is normal.

In an earlier paper (31) we reported a comparative study of the phosphatase activity of the blood and tumor tissues in a series of cases with bone tumors. Our study suggested that the quantitative determination of the phosphatase activity of the blood and tissue was of value in the study of these tumors. Since the publication of the above report, we have had the opportunity to bring the number of our observations to a total of 473 determinations in 202 cases to support our previous findings. The reader is referred to this report and to the paper by Franseen and McLean for detailed accounts of the values obtained in the various groups of bone tumors. We wish now to reaffirm the value of the phosphatase determination in the differential diagnosis of these conditions by reviewing the subject again to include the additional experience gained through our more recent observations together with the observations reported by others. We wish also to indicate how closely the theory of an

osteoblastic source of phosphatase is supported in cases with bone tumors, and how the range of phosphatase values may roughly be predicted from the gross and microscopic characteristics of the various types of lesions.

Most of our phosphatase determinations on blood plasma have been made according to a technique closely following that of Kay (17), and described in a previous paper (10). A few of the determinations on blood serum have been made by the Bodansky (6) method by the chemical laboratory of the Massachusetts General Hospital through the courtesy of Dr. Fuller Albright. In a number of cases, the determinations have been made by both methods. We do not favor one or the other method, since we have always found them to corroborate one another within the limits found significant for clinical use.

In normal adults, the phosphatase values for blood are most commonly found between 0.12 and 0.2 Kay units per cubic centimeter of blood plasma, with an average value of about 0.16 units, or, in Bodansky units, 2.5 to 4.0 units per 100 cubic centimeters of blood serum, with an average value of about 2.9 units. When interpreting the results, we have regarded all values in Kay units as normal up to 0.26 units per cubic centimeters of plasma, since we have obtained values up to this level in apparently healthy individuals. In Bodansky units we have regarded 5.0 units per 100 cubic centimeters of serum as the extreme upper limit of normal.

#### OSTEITIS DEFORMANS

Osteitis deformans was the first disease in which a high phosphatase activity of the blood was demonstrated (16), and a high value has been shown repeatedly to be the rule in well established cases. In most of the cases with this disease the only abnormality found in the blood is the increased phosphatase activity. Roberts (25) and Kay (18) suggested early that a rough proportionality existed between the level of the blood phosphatase activity and the extent of the bone involvement. This has since been confirmed by several investigators (8, 13, 22). Values varying from a normal figure in cases with quiescent monostotic lesions to the highest

values reported for any disease (30 to 40 times normal) have been found in cases of osteitis deformans with polyostotic lesions

The source of the high phosphatase activity in osteitis deformans appears to lie in the osteoblasts of the osteogenic tissues, for Franseen and McLean have demonstrated a very high phosphatase content of the actively proliferating tissue in the affected calvarium and ilium of an active case which came to autopsy, and Gutman, Tyson, and Gutman (14) have noted that extensive involvement of the skull is almost invariably associated with relatively high phosphatase values in the blood

The phosphatase level of the blood appears to depend upon the degree of activity and the extent of the disease, and the fact that it may show only minor fluctuations at a high level over a period of years as Gutman and Gutman have reported, indicates that the disease often may have long periods of sustained activity. The phosphatase level of the blood may recede at times also, and, by following the elevations and recessions of this level, the phosphatase test is found to be of clinical value in assaying the status of the disease at any time in an individual case or in indicating progress or arrest of the disease in any case followed over a period of time. It may thus serve as an index of the efficacy of any form of treatment employed and may also give an index of the prognosis in the study of an individual case. For example, we have cited (10) two cases in which fluctuations in the phosphatase values were observed at extraordinary high levels over many months. Both patients eventually died of osteogenic sarcoma.

The elevated level of the phosphatase activity of the blood in osteitis deformans is of limited value in corroborating a diagnosis made clinically or roentgenographically. In early monostotic cases, the phosphatase level of the blood may not be elevated and, unfortunately, in cases in which there may be confusion in differential diagnosis between osteitis deformans and for example osteoplastic carcinomatous metastases the phosphatase determination will probably be of no assistance since the phosphatase level is also elevated in this process with which osteitis deformans is perhaps most often confused.

#### HYPERPARATHYROIDISM WITH BONE INVOLVEMENT

Increased phosphatase values in hyperparathyroidism were first reported by Kay (16) and Hunter in 1929. In a review of this disease in 1934, Albright, Aub, and Bauer showed that the phosphatase level of the blood was proportional to the degree of involvement of the bones and independent of the degree of hyperparathyroidism. Gutman, Tyson, and Gutman have recently collected from the literature 28 cases of hyperparathyroidism with bone changes. The blood phosphatase was found to be increased in every instance from  $1\frac{1}{4}$  to 16 times the normal maximum value.

The phosphatase level, in this disease also is probably related to osteoblastic activity in the lesions, but we have had no opportunity to examine the phosphatase content of the tissue in the lesions themselves. The fact that the level of the blood phosphatase does not fall immediately after removal of the parathyroid lesion, is to be expected if we assume that the phosphatase is not produced by the parathyroid adenoma but by the osteoblasts attempting to repair the bone lesions. Under the same tenet it is not remarkable that the level of blood phosphatase activity should even rise somewhat during the acceleration of the osteoblastic activity in the repair process subsequent to the operative removal of the offending adenoma.

As a matter of fact, in one case of their series, Gutman, Tyson, and Gutman noted a fair degree of correlation between the rate of redeposition of bone observed roentgenographically after operation and the level of the serum phosphatase. At biopsy Albright, Aub, and Bauer found the osteoclasts already to have disappeared from the bone lesions 9 days after removal of a parathyroid adenoma.

It must be clearly recognized that the blood calcium and phosphorus determinations are distinctly of greater value than is the blood phosphatase determination in the study of this disease, since the phosphatase value merely indicates the degree of osteoblastic activity, hence of bone involvement, and not necessarily the degree of parathyroid activity.

Thus, a patient with hyperparathyroidism without bone lesions may have a normal phosphatase level

#### MYELOMA

Microscopically, the lesions of myeloma are purely destructive. As might be anticipated from this fact, no phosphatase activity is found in the tissues of the lesions (10), and the phosphatase level of the blood is practically unaltered even in the presence of numerous lesions. It is by virtue of the normality of the blood phosphatase in this disease that the quantitative determination of this enzyme may be of assistance occasionally in differentiating between a case with multiple myelomatous lesions and a case with carcinomatosis of the bones.

All investigators have reported normal levels of phosphatase activity in multiple myeloma, or at most a very slight elevation, with the exception of Rowntree, who reports that he has encountered "increased values in several cases." This is contrary to the theoretical expectation from the histological facts and from the demonstrable absence of phosphatase activity in the lesions themselves. When the phosphatase activity is elevated in the presence of multiple bone defects, a suspicion of carcinomatous metastases, hyperparathyroidism, or even lymphoma of bone should be entertained rather than myeloma.

#### CARCINOMATOUS METASTASES TO BONE

A small but definite phosphatase activity has been demonstrated by Franseen and McLean in the tissues comprising the metastatic carcinomatous lesions in bones; and in spite of the fact that the lesions may appear to be purely destructive roentgenographically, some reactive attempt at repair by the osteoblasts is invariably seen when the lesions are examined histologically. In single lesions the phosphatase activity of the tissues may be too small to be reflected in the level of the blood phosphatase, but when this activity is increased by multiplicity of lesions, there is invariably an elevation of the blood phosphatase level even in cases with the osteolytic type of metastases.

As might be anticipated, the blood phosphatase levels found in cases with carcinomatous metastases vary over a wide range, depending on the type and extent of the metastatic lesions. Theoretically, in the case of osteoplastic metastases, the increased osteoblastic activity should become manifest in the blood phosphatase value earlier, that is, when the lesions are fewer or smaller than in the case of osteolytic lesions. Gutman, Tyson, and Gutman's comparative series demonstrates this fact clearly. A large number of osteoplastic metastases may raise the blood phosphatase level to values among the highest reported for any disease, for example, Gutman, Tyson, and Gutman have reported values as high as 120.4 Bodansky units per 100 cubic centimeter of blood serum.

It has been suggested that the elevation of the plasma phosphatase in destructive metastatic disease in bone is due to a mobilization of the enzyme normally present in the bone which is undergoing destruction. The amount of phosphatase present in normal adult bone, however, is practically nil (10), and the fact that the plasma phosphatase level is almost invariably normal in myeloma, in spite of multiple and very extensive areas of dissolution of bone, is strong evidence against this theory.

A word of caution must be given in the interpretation of phosphatase values in the presence of either incipient or established jaundice in cases with bone lesions, particularly in cases with carcinomatous metastases, because jaundice itself is frequently associated with elevated values of blood phosphatase of non-osteoblastic origin. The significance of the increased phosphatase activity of the blood in jaundice and toxic hepatitis has been thoroughly reviewed by several workers (3, 4, 7, 11, 26, 29) and is pertinent to the study at hand only insofar as the presence of latent or manifest jaundice and liver injury vitiates the value of the test in cases with concurrent bone lesions.

That concomitant affections of the liver markedly influence the phosphatase level of the blood should be taken into account in interpreting the values obtained in cases with bone lesions. This is well shown by the case

with a chondral exostosis recently reported by Lamb and Blakely in which our determination showed 0.83 Kay units of phosphatase per cubic centimeter of blood plasma. This patient also had syphilis and was receiving arsenophenamine. Two days after the blood was taken for the phosphatase determination, the patient became jaundiced and it is believed that liver damage was the cause of the high reading. Woodard, Twombly, and Coley also found the phosphatase level of the blood in variably to be elevated after administration of Coley's toxins, and it is reasonable to suppose this elevation to be due similarly to a toxic effect upon the liver.

Minor degrees of obstruction produced by metastases in the liver, even when insufficient to produce clinical jaundice, may increase the phosphatase activity of the blood. Our experience agrees with that of Gutman, Tyson, and Gutman who state that, on the other hand there may be at times a large number of metastases in the liver without any significant elevation of the blood phosphatase. The possibility of the presence of metastases causing obstruction in the biliary system should, nevertheless, be borne in mind when interpreting the phosphatase values in cases with carcinomatous metastases in the bone owing to the likelihood of concomitant metastases to the liver. Usually the latter does not need to be considered in primary bone tumors, however, since metastases from them to the liver are very rare.

#### OSTEOMAS, CHONDROMAS, AND OSTEOCHONDROMAS

The osteoblastic activity, and consequently the phosphatase production, in this group of benign bone tumors is usually so slight that it does not measurably elevate the blood phosphatase. As we have suggested, the rate of its excretion or destruction may possibly keep pace with its rate of production.

According to our observations, the blood phosphatase values in the benign bone tumors such as osteoma, chondroma, and osteochondroma, have been quite constantly normal. At most, in uncomplicated cases, they have just exceeded the normal values. The phos-

phatase determination has been of no value in determining the possibility of the occurrence of malignant changes in a chondroma, since in 4 cases with chondrosarcomas the highest value found was 6.7 Bodansky units or 0.29 Kay units. At times, however, the increased osteoblastic activity in the malignant degeneration of a benign tumor which is producing new bone may be suggested by the increased phosphatase activity of the blood.

#### GIANT CELL TUMORS

Giant cell tumors of bone of non parathyroid origin are essentially destructive in character with little tendency toward new bone formation. The paucity of osteoblastic activity is evidenced by the inconstant slight rise in the blood phosphatase values. In the 8 cases in which we have had the opportunity to examine the blood the phosphatase has been at most only slightly elevated, usually to a high normal value. One patient, a child of 6 years and another with an accompanying pathological fracture, had moderately elevated values, 0.41 Kay units and 7.4 Bodansky units, respectively. The phosphatase activity of the tissues in the giant cell lesions is only slightly greater than that of osteochondromas.

#### EWING'S TUMOR

Since Ewing's tumor is chiefly destructive, the phosphatase level of the blood may be expected to be only slightly disturbed. This has been true of the 8 patients we have examined, none having had more than twice the highest normal value for phosphatase activity in the blood. We have had no opportunity, however, to test the phosphatase activity in the type of Ewing's tumor seen especially in the shaft of the fibula and characterized by marked reactionary, new bone formation in which it would seem likely that the phosphatase level of the blood would be considerably elevated. Owing to the inconstancy of osteogenesis in Ewing's tumor, the level in the blood bears no constant relation to the extent of the disease, and the tissues of the lesions themselves which we have examined have shown only a trace of phosphatase activity.

## OSTEOGENIC SARCOMA

The phosphatase level of the blood in cases with osteogenic sarcoma is almost invariably elevated to some degree. This level depends primarily upon the product of 2 factors; namely, the rate of growth, i.e., the osteoblastic activity of the lesions; and the size of the lesion, i.e., the number of malignant osteoblasts producing phosphatase. The level may vary from a very low one to levels among the highest reported for any disease. The highest value in our group was 4.79 Kay units per cubic centimeter of blood plasma, practically 20 times the highest normal value.

That the phosphatase elevation of the blood is the result of this lesion and not the cause of it, and that the osteogenic lesion is the source of the increased phosphatase activity of the blood, is strongly suggested by our observations showing that after removal of the lesion by amputation, the blood phosphatase returns to normal limits within a short period of time, usually in about 2 weeks. Our previous report (31) on this phenomenon was based on observations in 6 cases. We have since had the opportunity to study 5 additional cases in which a similar effect was observed.

The phosphatase level of the blood may become elevated again after the initial post-operative fall when latent metastases have become apparent. We have been unable, however, in the cases we have had an opportunity to follow, to prophesy the subsequent appearance of latent pulmonary metastases by the changes in the phosphatase values prior to the demonstration of the lesions roentgenographically. An example of this is the case of a 14 year old girl with an osteogenic sarcoma of the femur, whose serum phosphatase fell promptly to normal after amputation. However, one month after a normal phosphatase value had been obtained, she reported with clinical and roentgenographic evidence of pulmonary metastases. Thus, the phosphatase test appears not to be sufficiently sensitive to reveal small foci of osteogenesis. It has been found that pulmonary metastases must be of considerable size or number before they can be detected by the phosphatase determination, perhaps due to the fact that pulmonary metastases not infrequently show only minor de-

grees of osteogenesis. A roentgen examination of the chest is the best means for their detection.

That the osteogenic tumor is the source of the elevated blood phosphatase in this disease is further strengthened by the fact that very high degrees of phosphatase activity have been demonstrated in the tumor tissues themselves. Even metastases which are isolated from bone have been demonstrated to be high in phosphatase activity, as for example, metastases from osteoblastic tumors in the lungs or in the superficial soft parts. We have reported values as high as 95 Kay phosphatase units per gram of tissue in an osteogenic pulmonary metastasis in a young man of 23 years, and 209 units per gram in a primary osteogenic sarcoma in an adolescent boy (10).

## DIFFERENTIAL DIAGNOSIS

In the differential study of cases with bone lesions, it must be conceded that the roentgenological examination of suspected cases of bone lesions makes the greatest independent contribution toward the establishment of the diagnosis; but even the X-ray picture is frequently equivocal, and confirmation or exclusion of the suggested diagnosis before operation often must rest upon the reports of the chemical laboratory. The importance of blood chemical determinations other than phosphatase, i.e., calcium, phosphorus, and serum protein, in the study of bone lesions obviously cannot be denied, and their values must also be considered together with the facts obtained from roentgenological and physical examinations, historical data, or additional laboratory data such as serological tests for syphilis, examinations of blood smears, and tests for Bence-Jones protein in the urine.

If the rôle of the phosphatase determination in the differential diagnosis of bone lesions is to be discussed with any degree of completeness, the rôle of other chemical constituents of the blood, especially calcium and phosphorus must be considered at the same time. Gutman, Tyson, and Gutman have made a comprehensive review of the chemical findings in reported cases of the bone lesions herein discussed, together with the histories of their own patients. We have also made cal-



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If the rôle of the phosphatase determination in the differential diagnosis of bone lesions is to be discussed with any degree of completeness, the rôle of other chemical constituents of the blood, especially calcium and phosphorus must be considered at the same time. Gutman, Tyson, and Gutman have made a comprehensive review of the chemical findings in reported cases of the bone lesions herein discussed, together with the histories of their own patients. We have also made cal-

cium and phosphorus studies in many of our own cases. From this combined experience we have constructed the accompanying table in summary of the results of calcium, phosphorus, and phosphatase determinations among the bone lesions herein considered. Hyperproteinemia and Bence Jones proteinuria have also been included because of their importance in the differential diagnosis when present.

The difficulty in making a differential diagnosis by blood chemical means among hyperparathyroidism, multiple myeloma, and multiple carcinomatous skeletal metastases in which no primary source has been found (all of which may at times be confused roentgenographically) lies in the fact that hypercalcemia has at times been reported in all 3 conditions. Thus, hypercalcemia occurs almost as a rule in hyperparathyroidism, especially in cases with bone involvement, it occurs frequently in multiple myeloma and occasionally in cases with widespread skeletal metastases. In the latter 2 conditions it has been suggested that the hypercalcemia is related to the mobilization of the calcium in the dissolution of the bone or to co incident renal insufficiency. The almost invariable association of hypophosphatemia with the hypercalcemia in hyperparathyroidism is of occasional assistance, but hypophosphatemia has also been found in cases of carcinoma with advanced skeletal metastases associated with cachexia, and also in multiple myeloma, but in the latter 2 conditions, a normal or elevated serum phosphorus is found more commonly even when hypercalcemia is present (2, 14). The blood phosphatase determination is occasionally of assistance among these patients, owing to the fact that even in the presence of extensive lesions of multiple myeloma, the blood phosphatase is almost invariably normal, whereas with multiple lesions from either metastatic carcinoma or hyperparathyroidism the phosphatase level would be elevated at least somewhat, and occasionally elevated to quite a high level. In the differential diagnosis between metastatic carcinoma and hyperparathyroidism, the blood phosphatase perhaps would not be of much assistance, though it is probably higher in the latter condition when the lesions are of comparable extent.

The blood chemical findings may at times only add to the confusion. For example, Gutman, Tyson, and Gutman report that they have encountered findings similar to those which are usually thought characteristic of hyperparathyroidism in occasional cases of carcinoma with advanced skeletal metastases. They suggest that the hypercalcemia in these cases is related to the destruction of the bone by the neoplastic process, the hypophosphatemia probably to cachexia, and the increased blood phosphatase to involvement of the bone or liver. In such cases, the phosphatase determination would not be of much assistance in differential diagnosis, but fortunately at the stage of the disease when this confusion over the clinical findings would arise, the primary carcinomatous lesion is often evident.

The determination of the presence or absence of Bence Jones proteinuria may be of value, since Bence Jones proteinuria has been observed in cases of hyperparathyroidism only in rare instances, and then only in very small amounts (1), and its occurrence in cases with skeletal metastases from carcinoma is probably also quite rare. The finding of Bence Jones proteinuria is of assistance in diagnosis only in 50 to 70 per cent of the cases with multiple myeloma in which it may intermittently appear. The occurrence of hyperproteinemia, also, may be of some assistance in suggesting the diagnosis of myeloma. It is only of irregular occurrence, however, and often does not appear until late in the disease. The serum protein level is probably always normal in carcinoma with metastases and in hyperparathyroidism.

Osteitis deformans may occasionally enter into differential diagnosis especially with osteoplastic skeletal metastases from carcinoma or possibly, in an early exceptional case of Ewing's tumor in an older individual in whom the only changes present in the bone may be an increase in density. In early cases the blood phosphatase level may be slightly elevated in all 3 conditions. In more advanced cases with osteoplastic metastases from carcinoma and in osteitis deformans also the blood phosphatase is always elevated, perhaps relatively more in the latter. In

TABLE I—ANALYTICAL FINDINGS IN VARIOUS BONE LESIONS

Bone lesion	Blood phosphatase	Hypercalcemia	Hypo-phosphatemia	Hyper-proteinemia	Bence-Jones proteinuria	Tissue phosphatase
Hyperparathyroidism (with bone lesions)	Moderately elevated	Almost always	Usually	Absent	Rarely	?
Osteitis deformans	Usually very high	Practically never	Practically never	Absent	Absent	Slight to high
Metastatic carcinoma	Normal to high	Rarely	Very rarely	Absent	Very rarely	None to slight
Osteogenic sarcoma	Moderately elevated to high	Absent	Absent	Absent	Absent	Slight to very high
Multiple myeloma	Almost invariably normal	Often	Very rarely	Often	Often	None
Ewing's tumor	Normal to slight	Absent	Absent	Absent	Absent	None to slight

Ewing's tumor, however, the elevation has never been found to be great even in late stages of the disease. In all 3 conditions the serum calcium and phosphorus values of the blood are normal, except in rare cases with associated renal insufficiency in which both the calcium and phosphorus may be somewhat elevated (14, 23).

It must be remembered, also, that osteitis deformans may exist concurrently with other tumors. In our own series a case occurred with a sarcoma in the head of the tibia of a woman 50 years of age, and the question of the simultaneous occurrence of Paget's disease of the bones of the pelvic girdle arose. In this instance the blood phosphatase value was high, and contrary to the usual experience after removal of a tumor of osteogenic character, it did not return to normal after amputation. Subsequently, the diagnosis of Paget's disease became unequivocal and the blood phosphatase activity continued at an elevated level. The tumor in this case was fibrous in character with only a small amount of reactionary, new bone formation in the periosteum. There was no phosphatase activity of the homogeneous tumor tissue taken at a distance from the periosteum.

In all cases with multiple bone lesions the possibility of malignant lymphoma should also be borne in mind. In the differential diagnosis of the latter the characteristics of the blood smear, the presence of hepatomegaly, splenomegaly, or enlargement of the lymph nodes are helpful in suggesting the diagnosis. Since the lesions of lymphoma are often osteoplastic as well as osteolytic, as Dresser and Spencer

have shown, the phosphatase values may be expected to be quite variable in this disease, especially when hepatic changes may be concomitant and may themselves produce an elevated phosphatase activity of the blood. Four of five cases with lymphoma and bone involvement showed phosphatase activity above normal, but varying from a slight elevation (0.27 Kay units per cubic centimeter) to a rather high value (0.95 Kay units per cubic centimeter) in a case with extensive osteoplastic lesions.

Criticism has been directed against the diagnostic value of the phosphatase determination in bone lesions because of its lack of specificity, but chemical determinations absolutely specific for definite diseases are exceedingly rare, all must be interpreted in relation to other findings. Neither the occurrence of hypercalcemia nor even of Bence-Jones proteinuria is specific, yet none would deny their diagnostic value. The phosphatase activity of the blood is an important member of the group of chemical determinations on the blood, namely, calcium, phosphorus, serum protein, and phosphatase, all of which are of value in the differential diagnosis of bone lesions.

#### SUMMARY

Evidence is adduced to support the theory that the increased phosphatase activity of the blood in patients with bone lesions is the product of the intracellular activity of the osteoblasts. The level of the phosphatase activity found in the blood in the presence of a bone lesion corresponds closely to the theoretical expected level determined by a study of

the gross and microscopic evidence of the osteoblastic activity in the lesion

Owing to the fact that the phosphatase activity of the blood varies in proportion to the osteoblastic propensities of the individual type of bone tumor, the phosphatase determination is often useful in the differential diagnosis of bone lesions

The relationship of the phosphatase activity of the blood to calcium, phosphorus, and serum protein values found in various bone lesions is discussed

### BIBLIOGRAPHY

- ALBRIGHT F Hyperparathyroidism *Med Clin N America* 1915 January, 1109
- ALBRIGHT F, ALB J C and BAUER W Hyperparathyroidism *J Am M Ass* 1934 102 1276
- ARMSTRONG A R and KING E J Serum phosphatase in toxic and hemolytic jaundice *Canadian M Ass J* 1935 32 319
- ARMSTRONG A R, KING E J and HARRIS R J Phosphatase in obstructive jaundice *Canadian M Ass J* 1934 31 14
- AUSTOVI E and COCCO G La Phosphatase du plasma dans différentes affections *Pres e med* 1934 42 1393
- BODANSKY A Phosphatase studies II Determination of serum phosphatase *J Biol Chem* 1933 101 95
- BODANSKY A and JAFFE H L Phosphatase studies IV Serum phosphatase of non osseous origin significance of the variation of serum phosphatase in jaundice *Proc Soc Exper Biol & Med* 1933 31 107
- Idem Phosphatase studies III Serum phosphatase in diseases of bone interpretation and significance *Arch Int Med* 1934 54 88
- DRIBLER R and DIENCKER J Hodgkin's disease and allied conditions of bone *Am J Keetingen* 1936 36 809
- FRANSEN C C and McLEAN R The phosphatase activity of tissues and plasma in tumors of bone *Am J Cancer* 1935 24 99
- GREENE L H, SHATTUCK H F and KAPLOWITZ L The phosphatase content of the blood serum in jaundice *J Clin Invest* 1934 13 1079
- GUTMAN A B and GUTMAN E L Paget's disease relative constancy of serum phosphatase levels over periods up to two years *Proc Soc Exper Biol & Med* 1935 31 150
- GUTMAN A B and KASABACH H H Paget's disease (osteitis deformans) Analysis of 110 cases *Am J M Sc* 1936 191 361
- GUTMAN A B, TYSON T L and GUTMAN E B Serum calcium inorganic phosphorus and phosphatase activity in hyperparathyroidism Paget's disease multiple myeloma and neoplastic disease of the bones *Arch Int Med* 1936 57 319
- HUNTER D Hyperparathyroidism (hyperfunction of a parathyroid tumour in a case of generalized osteitis fibrosa) *Proc Roy Soc Med (Sect Med)* 1939 32 227
- KAY H D Plasma phosphatase in osteitis deformans and in other diseases of bone *Brit J Exper Path* 1929 10 233
- Idem Plasma phosphatase I Method of determination Some properties of the enzyme *J Biol Chem*, 1930 89 135
- Idem Plasma phosphatase II The enzyme in disease particularly in bone disease *J Biol Chem*, 1930 89 240
- Idem Phosphatase in growth and disease of bone *Physiol Rev* 1931 12 384
- LAMB C A and BRADLEY E A study of phosphatase elevation in neoplasms and administration *New England J Med*, 1937 217 353
- MORRIS N and PEDER O D Plasma phosphatase in disease A review *Quart J Med* 1937 6 211
- O'REILLY T J and RACE Joseph Osteitis deformans *Quart J Med* 1937 1 491
- ORFORD G H Calcium changes and their importance in diagnostic radiology *Brit J Radiol* 1936 9 102
- PAUTRAY J Etude de la phosphatase plasmatique *These med Paris* 1935
- ROBERTS W M Variations in the phosphatase activity of the blood in disease *Brit J Exper Path* 1930 11 90
- Idem Blood phosphatase and the van den Bergh reaction in the differentiation of the several types of jaundice *Brit M J* 1935 1 734
- ROBINSON R The possible significance of heterophosphoric esters in ossification *Biochem J* 1923 17 286
- ROBINSON R and SOAMES K M Part II The phosphoric esterase of ossifying cartilage *Biochem J* 1924 18 740
- ROTHMAN M M, MERANZE D R and MERANZE T Blood phosphatase as an aid in the differential diagnosis of jaundice *Am J M Sc* 1936 192 526
- ROUNTREE L G Progress relative to diseases of the ducts *Standards Pennsylvania M J* 1933 36 646
- SINHO S C C and FRANSEN C C The diagnostic value of phosphatase determinations in the study of bone tumors *Ann Surg* 1935 10 555
- WOODWARD H Q and HERRICOTHAM N L The correlation between serum phosphatase and roentgenographic type in bone disease *Am J Cancer* 1917 31 221
- WOODWARD H Q, THOMLEY G H and COLBY B L A study of the serum phosphatase in bone disease *J Clin Invest* 1936 15 193

# EXPERIMENTS CONCERNING LIGATION AND REFRIGERATION IN RELATION TO LOCAL INTOXICATION AND INFECTION

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SEVERAL previous papers (1) have described a plan of animal experiments in which limbs or viscera are deprived of circulation by means of a tourniquet and then kept at a temperature near 0 degrees C for various periods, up to 16 hours for intestine and more than 2 days for limbs, with the result that they can afterward be restored intact without local necrosis or systemic shock. Suggestions were also made for possible clinical applications of this method. This paper describes experimental observations pertaining to intoxication and infection and discusses points which may merit clinical investigation.

## EXPERIMENTS WITH STRYCHNINE

Strychnine sulphate was chosen as an example of a poison which is quickly absorbed and quickly oxidized. If a fatal dose of 1 milligram or slightly more be injected into the leg of a 2 kilogram rabbit, it may be possible to wait more than 1 minute until the first beginning of muscle spasms, and then check the symptoms by applying a tourniquet. For the sake of brevity, it may suffice to state only the course of events when a huge excess is injected, for example, 10 or 12 milligrams, or about 10 times the fatal dose. It is not possible then to wait 1 minute, for by the time of the first muscle spasm the absorption is so great that a tourniquet can no longer save life. In this case the tourniquet should be applied arbitrarily in 30 seconds or at least at the first detectable increase of reflexes. If the necessary course of tourniquet applications were to be performed at ordinary temperatures, considerable local inflammation and perhaps systemic shock would result. These consequences are avoided by immediately immersing the leg in ice water. In this condition the animal is safe for an indefinite number of

hours, but the strychnine remains. Therefore, the ordinary procedure is the following. After an arbitrarily chosen period of 15 to 30 minutes the leg is removed from the ice water and the tourniquet is released. After 30 seconds the tourniquet is re-applied and the leg is again immersed. This process is repeated until cautious tests show that the diminished store of the poison permits the lengthening of the time of release to 1 minute and then several minutes. Watchfulness is necessary right to the end, for fatal strychnine convulsions have sometimes developed more than 15 minutes after the last tourniquet release. Depending upon the length of the periods of ligation and release, the rabbit may be finally freed in perhaps 16 to 24 hours without any important damage to the leg and without having shown any symptom of poisoning from 10 times the fatal dose.

Some rabbits which received enormous doses have died from simple weakness within a few days. It is undecided whether this result represents a delayed action of the strychnine, perhaps upon some organ other than the nervous system, or whether it is due to carrying through the experiment too rapidly or to any indefinite injury or strain of the procedure. It does not occur with smaller doses and is not significant for the present subject.

The only clinical example of poison entering through the limbs with any frequency seems to be snake bite. This differs from strychnine in that the poison is slowly absorbed, slowly destroyed, and is capable of serious local damage. The refrigeration method may with some modifications prove useful occasionally according to experiments with snake venom published elsewhere (2).

Another practical use of the refrigeration method is its use in infections in limbs. The cases must be divided into those in which

there is to be an attempt to save the limb and those in which the limb is to be amputated

#### REFRIGERATION WITHOUT AMPUTATION

Since blood and various tissues can be kept in a state of suspended animation in the ice box for several weeks or months without evident impairment of vitality, and since the normal legs of animals can likewise be kept ligated and refrigerated in ice water for at least a day or two and then restored to function, there is some temptation to learn what will happen if this procedure is applied to infected limbs. The speculation centers about the fact that the tourniquet instantly cuts off the flow of toxins from the limb, while the temperature presumably inhibits growth and other activity of the bacteria in the limb. In addition to the possible chance of devising any treatment for the limb at this temperature, there is the principal consideration of giving the patient at least a brief vacation from the intoxication, during which he may gain in strength and nutrition, receive any general or specific treatment, or develop antibodies which he may not have had time or ability to produce in the presence of an advancing infection. On the other hand the danger lies in the chance that removal of the tourniquet may not merely restore the status quo ante, but that the refrigeration period may entail damage to the limb or perhaps an overwhelming accumulation of bacterial or tissue toxins.

One series of experiments consisted in injections of a heavy suspension of rat feces into the legs of cats and dogs. Local abscesses and necrosis and systemic malaise and intoxication ranging from slight to fatal in degree, could thus be produced in a fairly controllable manner according to the dose. The refrigeration treatments may be divided roughly into short and long. In the former the stoppage of circulation and immersion in ice water lasted from 2 to 5 hours. The effects were only slight and as far as the course of the infection was changed at all it was slightly for the worse. In the long treatments the use of the tourniquet and refrigeration was continued for periods of 24 to 48 hours. Spectacular improvement was obtainable during such periods in dangerously intoxicated animals. The imme-

diate benefit was greater than with amputation because of the absence of the shock of amputation. At the time of release of the tourniquet the limb appeared unchanged and the circulation returned promptly. Extensive masses of tissue, however, quickly turned dark and gangrenous, vessels became thrombosed, and the absorption of poison was so rapid that often the animals died in spite of early and high amputation. The rapidity of these changes created the impression that the chilling abolished certain vital barriers to the diffusion of bacterial products, that while the growth of bacteria might be inhibited, their existing toxins were able to spread with increased freedom and to form chemical combination with the protoplasm. The practical lesson at least was plain, namely that prolonged ligation and refrigeration are positively contra indicated in the presence of any necrotizing infection if it is planned to restore the circulation afterward.

In another series of experiments with the aid of Dr C A Vicens and Mr J G Rice, the attempt was made to imitate another type of infection. This was done by injecting pure cultures of various streptococci into the legs of rabbits. The results were either a trivial local process or an overwhelming systemic invasion according to the dose. Also the addition of vegetable mucin to the injections failed to reproduce the desired clinical condition, namely, a local cellulitis and lymphangitis spreading up the leg and finally inducing septicemia. Treatments with the tourniquet and refrigeration were of no value whether long or short. Necessarily the infection was held in check during the period of treatment but the ultimate outcome was always more or less in favor of the untreated animals and with certain doses of culture it was possible for the untreated animals to live while the treated ones died. This result might readily be accounted for by the general strain and chilling in such a feeble animal as the rabbit. There was no opportunity to make the real test which would consist in holding an invasive infection in check for a day or two to give the animal time to develop antibodies under favorable conditions. The most definite fact elicited seemed to be that the streptococcus and its toxins did

not cause any gross tissue necrosis during the refrigeration or any gangrene after release of the tourniquet. In general, therefore, further trials of refrigeration in coccal infections did not seem to be entirely precluded.

Granting, as assumed above, that chemical combinations of bacterial products can occur during refrigeration, it was a natural suggestion to make use of the principle with antisera. In the refrigerated limb without circulation, not only may the increased permeability favor the penetration of the serum throughout the tissues, but it is also feasible to keep a high concentration of serum in direct contact with the tissues for long periods in a manner which is impossible with the blood flowing. Furthermore, it seems conceivable that the low temperature may alter the permeability of the membranes or protective envelopes of the bacteria themselves.

Accordingly, a few experiments were tried in which rabbits' legs were injected with streptococcus cultures, and subsequently with a polyvalent antistreptococcus serum.<sup>1</sup> The tourniquet and refrigeration were then applied as usual for several hours. These experiments had to be broken off in a preliminary stage before either positive or negative results could be definite. Such a research demands bacteriological facilities, also a true local infection and the appropriate antiserum. As some of these requirements could not be fulfilled, no conclusion could be reached.

A single clinical observation was made:

An obese woman, aged 56 years, evidently diabetic long before the diagnosis 11 years previously, had gangrene of the right foot 9 years before, and as the arterial changes were chiefly below the knee, amputation through the upper tibia was successful. In the subsequent years she violated diet repeatedly, several small gangrenous infections caused losses of portions of toes of the right foot but healed each time on control of the sugar. One week before admission an infection of a different type began with painful swelling in the ball of the foot, which extended rather rapidly in spite of treatment by her local doctor together with adequate insulin and diet control. She was admitted to the hospital in a supposedly critical condition, with extremely painful swelling up to mid-calf, pink and white mottling was present but no dark color anywhere, and temperature ranged between 102 and 104 degrees. With local measures and strict diabetic treatment for 4 days the process ex-

tended almost to the knee. It was regarded as probably a streptococcal cellulitis. Roentgenograms showed no bone involvement, blood cultures were negative, but septicemia was feared and a surgeon was called to consider possible amputation. A short incision at the original point of swelling in the sole yielded only a thin serous discharge from which a culture was taken. It was decided to take the chance with refrigeration treatment as follows.

A tourniquet of rubber tubing was applied below the knee tightly enough to stop all circulation. The leg was immersed in ice water up to this tourniquet. The pain, which had been excruciating, began to subside within a few minutes and within half an hour was absent. Then 150 cubic centimeters of Lederle's polyvalent streptococcus-staphylococcus serum (purchased at a local drug-store) was diluted with an equal volume of Ringer solution, and the mixture was injected by multiple punctures so as to infiltrate the foot and leg as thoroughly as possible. After 3 hours the leg was removed from the ice water and the tourniquet released. Severe pain soon returned but no bad effects were evident. The rectal temperature steadily fell within 3 days to 100 degrees, and general and local recovery quickly followed. The culture from the foot yielded *Staphylococcus aureus* and a non-hemolytic streptococcus.

The patient left the hospital after 2 weeks, apparently in good condition except for considerable persisting pain. After another week, although the small exploratory incision was nearly healed and all obvious infection was absent, another small painful area developed more posteriorly and began to turn dark. Amputation was therefore performed below the knee, with a tourniquet and refrigeration for 4 hours as the only anesthetic. The subsequent course was uneventful except for the extrusion of 2 small sequestra.

There is no proof that the treatment with refrigeration and serum was of any value, for recovery might have occurred similarly without it. Evidently infiltration of the chilled tissues was a mistake, for such tissues become so firm and resistant that the infiltration probably causes breaks and tears, which may be suspected as the cause of the prolonged pain and perhaps also of injuries to small blood vessels. It therefore appears preferable to infiltrate with added novocain or other anesthetic after the placing of the tourniquet but before refrigeration. On the other hand, in view of the history and the state of the leg, there is no proof that the treatment was responsible for the failure to save the limb. At least the amputation was delayed and the field restricted so that healing was obtained below the knee instead of the thigh amputation which would have been necessary at the beginning. With 2

<sup>1</sup>Supplied for the purpose through the courtesy of Lederle & Co.



good knees the patient is looking forward to a rather active life. The single experience shows that no acute catastrophe need occur from brief refrigeration even of a badly nourished and infected limb. A second refrigeration for amputation was followed by healing which seemed very satisfactory under the conditions. Owing to the uncertainties, there is no present intention of using the refrigeration method again for limbs not to be amputated unless more definite experimental support is obtained.

It should be emphasized that the above reservations apply only to infected parts. For non infected parts the existing experimental evidence is believed to establish positively the benefits of refrigeration, in creating tolerance for longer deprivation of circulation with less injury than at higher temperatures. Examples of probable clinical application are as follows (1) for embolectomy and all other emergency operations after stoppage of the main artery of a limb, (2) for plastic or other operations which involve the use of a tourniquet for 1 to several hours, so that at least ice bags and iced sponges should be used during all such operations, (3) as a simple and harmless local anesthetic under various conditions. In general, the hopes are for an extension of the limits and improvement of the results of reparative and emergency surgery of limbs, inasmuch as immediate refrigeration can certainly keep a bloodless limb in much better condition during a more or less extended period before operation can abolish pain and shock, and can perhaps mitigate the effects of trauma so as to favor subsequent healing.

#### REFRIGERATION PREPARATORY TO AMPUTATION

The technique consists in applying a rubber tube (not a broad tourniquet) well above the proposed level of amputation tightly enough to stop circulation after elevating the limb to drain out blood. The limb may then be immersed in ice water to slightly above the tourniquet or for a weak patient it may be surrounded with ice inside a rubber sheet, for example by channeling a block of ice for the thigh to rest on and piling cracked ice above it. Though sedatives may be desirable for discomfort or nervousness at the outset, within

about half an hour there is relief from even the most severe pain of gangrene. If the procedure is properly carried out, within 4 or 5 hours, depending on the thickness of the limb, there is such anesthesia present that the sciatic nerve can be cut without reaction. After ordinary preparation of the field, the operation can be done bloodlessly and apparently without the bad consequences which formerly contra indicated the use of a tourniquet in diabetic and arteriosclerotic limbs. Sponging is done with iced saline, etc. Shortly before skin closure the tourniquet is released so any bleeding points may be ligated. The anesthesia persists about long enough for the skin suture.

Surgeons are often prejudiced against the novel idea of chilling the tissues and also the mess created by the use of ice. If usage warrants, it doubtless will be feasible to devise an apparatus for dry refrigeration which will fulfill the requirements of accurate chilling without freezing. Aside from incidental advantages, the proposed plan has a rationale similar to Crile's anoxic association. It is based upon the belief that in spite of anesthesia of the central or peripheral nervous system, tissues react to severe trauma in a manner which is detrimental to local healing and which also involves production of the toxic substances causing shock. Refrigeration certainly inhibits its shock and perhaps favors healing. The method has been used for only 3 human amputations and it can be said with due reservation that in this small experience no harm has been perceptible either to the tissues from the chilling or to the arteriosclerotic vessels from the tourniquet. The main basis of the suggestion is a large series of animal experiments. The results seem to warrant the hope that an amputation method which obviates pain, shock, and anesthesia may have some clinical usefulness. The incidental advantages of the method may be discussed with respect to (A) shorter and (B) longer refrigeration periods.

A. A patient with gangrene or infection is often received in a state of severe pain, intoxication, and weakness, and nevertheless must wait often 6 to 12 hours before operation during which time he is quieted with somewhat detrimental doses of morphine. If a member of the house staff should merely apply a tour

niquet and chill the limb, the patient would shortly be comfortable without drugs; there would be a better response to routine treatment and an appreciable subsidence of intoxication and fever, and everything could be in readiness upon the surgeon's arrival for operation without the usual anesthesia and other preliminaries. Such an amputation would be done a little below level of tourniquet as described.

B An occasional patient is in such desperate condition that he will probably die from the operation and will certainly die without it. In such a case there is need for a method which will even temporarily offer the benefits of amputation without its dangers. Several surgeons have stated in personal communications that under these conditions they have sometimes applied a tourniquet at ordinary temperature in order to gain a respite of only a few hours. The advantage of refrigeration is that it extends these time limits, so that without any of the shock of amputation a patient can be kept comfortable for 2 days or if necessary longer, with the source of pain, toxemia, or bacteremia cut off as effectively as if there had been an amputation, thus furnishing opportunity for transfusion or other restorative treatments. Amputation should then be performed not below but at the level of the tourniquet, since the viability of tissues in a diseased or infected limb could not be trusted after such prolonged absence of circulation. If necessary, a higher tourniquet could be applied and the refrigeration carried correspondingly higher for a few hours to provide anesthesia for the operation.

#### SUMMARY AND CONCLUSIONS

1 When a poison such as strychnine is injected into a limb, a suitable series of treatments with tourniquet and refrigeration makes it possible to tolerate many times the fatal dose without harm.

2 A temperature slightly above 0 degrees C in a limb reduces the metabolism of the tissues so as to enable them to withstand absence of circulation safely for hours or even days, a fact based on the same principle by which blood corpuscles and tissue fragments are preserved for weeks or months in the ice box without loss of vitality. It is believed

that this principle has definite applications in practical limb surgery, as discussed, especially for emergency and reparative operations.

3 As the low temperature must also arrest bacterial activity almost completely, the speculative question arose whether the tourniquet and refrigeration could be used to stop the flow of toxins or bacteria from an infected limb, so as to allow an interval for rest and development of strength and antibodies. The question included also the possibility of special treatments during this interval, especially the effects of infiltrating the isolated limb with a specific antiserum which could thus be held for a long time in high concentration in the infected area. It was learned positively that long treatments cannot be used for any necrotizing infections, because of the gangrene which results from the prolonged contact of such toxins with the tissues even at low temperature. Also refrigeration for more than a few hours is believed to be contra-indicated in any limb which is to be saved. Short treatments of this kind do not cause gangrene in infections with organisms such as the ordinary cocci, and the method was actually tried in one human case. The investigation had to be abandoned for lack of facilities, and there is at present no proof that the plan is beneficial or that it may not be slightly harmful.

4 The refrigeration method can obviate pain, shock, toxic absorption, and the need for anesthetics. It can probably, therefore, have at least occasional usefulness in preparation for amputations. Owing to the very small clinical experience in comparison with the numerous animal experiments, the statements are largely theoretical and the exact clinical benefits or limitations still await decision.

#### REFERENCES

- 1 ALLEN, F. M. Local asphyxia and temperature changes in relation to gangrene and other surgical problems. *Tr. Ass. Am. Physicians*, 1937, 52: 189. Ligation and refrigeration of intestine. *Surgery*, 1938, 3: 893-898. The tourniquet and local asphyxia. *Am. J. Surg.*, 1938, 41: 192-200. Resistance of peripheral tissues to asphyxia at various temperatures. *Surg., Gynec. & Obst.*, 1938, 67: 746-751. Effects of ligations on nerves of the extremities. *Ann. Surg.*, 1938, 108: 1088-1093. Physiological and toxic factors in shock. *Arch. Surg.*, 1939, 38: 155-180.
- 2 Idem. Mechanical treatment of venomous bites and wounds. *Southern M. J.*, 1938, 31: 1248-1253.

# ANALYSIS OF IMMEDIATE POSTOPERATIVE COMPLICATIONS IN 2,000 CASES OF INGUINAL HERNIA

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**T**HIS study was undertaken to obtain facts concerning postoperative complications in a group of apparently healthy individuals who underwent similar types of operations. All of these persons were operated upon for simple inguinal hernia, either oblique or direct in type. Consecutive cases have been chosen, except that any case in which an abnormality was noted at the time of the pre-operative physical examination or a complication of the hernia was recorded at the time of operation was disqualified from inclusion in this series. All of these individuals had, to the best of our knowledge, normal cardiovascular, renal and respiratory systems and none of the hernias were incarcerated or strangulated. The majority of these individuals had some type of test for syphilis and, if positive, this case was eliminated. The operations were performed by some fifteen different surgeons of the surgical staff of the Hospital for the Ruptured and Crippled, between the dates of January 1, 1933, and July 1, 1936. Approximately the same technique was used by all.

In the 2,000 cases there were 1,508 operations for single and 492 for bilateral hernias (2,402 actual operations). Of the single hernias 838 were on the right side (56 per cent) and 650 on the left. Only sixty-two (3.1 per cent) were in females. Fifty-seven per cent of the single hernias in the males and 60 per cent in the females were on the right side. Twenty-five per cent of the males were operated upon for bilateral hernia and only 12.3 per cent of the females. Only 88 (4.5 per cent) of the individuals were over 60 years of age; the ages of the remainder were distributed fairly evenly through the first 6 decades of life. The smallest number in this last group (8.3 per cent) were in the second decade. Seventy-five per

cent of the individuals were between the ages of 20 and 59 years, inclusive.

There were 321 cases (16 per cent) in which postoperative complications were noted (Table I) with 5 deaths (0.25 per cent). All of the deaths were in cases of single hernia in men. Two were due to pneumonia and 3 to pulmonary emboli.

Almost twice as many complications occurred in patients operated upon for bilateral hernia (23.1 per cent) as for single (13.7 per cent). The rate of complications was slightly higher in those operated upon for right inguinal hernia (14.5 per cent) than for left (12.6 per cent). Complications followed operation more often in the case of the male than in that of the female patient; in 1938 cases of the former there were 313 (16.3 per cent) who developed complications and, in the 62 of the latter, 8 (12.9 per cent).

Considered according to age there was a well marked increase in complications occurring from the third decade of life onward (Chart 1). During the first two decades of

TABLE I—COMPLICATIONS

	Cases	Per cent
Wound hematomas	17	9
Wound infection	50	4.9
Respiratory lesions	171	8.5
Thrombophlebitis	6	3
Marked postoperative distention	6	3
Persistent headache (following spinal anesthesia)	4	2
Iodine dermatitis	2	1
Cystitis	2	1
Severe hiccoughing (local anesthesia)	1	0.5
Gastric dilatation (spinal anesthesia)	1	0.5
Postoperative psychosis (general anesthesia)	1	0.5
Jaundice (spinal anesthesia)	1	0.5
Bacillary dysentery	4	2
Measles	1	0.5
Scarlet fever	1	0.5
Mumps	1	0.5
Otitis media	1	0.5
Unexplained diarrhea	1	0.5
Toxic erythema	1	0.5

From the General Surgical Service of the Hospital for the Ruptured and Crippled

life the rate was low in cases of both single (11.1 per cent) and bilateral (9 per cent) hernias. During the third decade the rate remained approximately the same as in the previous decades in the cases of single hernia (9.7 per cent), but there was a sharp rise (17.1 per cent) in the rate for those of bilateral hernia. After the thirtieth year there was a fairly uniform rise in the rate of complications for each succeeding decade in the cases of single hernia, to a maximum of 24 per cent in persons over 60 years of age. A similar rise was noted in the cases of bilateral hernia; the steepness of the curve, however, was more marked and finally reached 35 per cent for individuals over 60 years of age.

There were 2,492 operative wounds in the 2,000 cases. In 17 instances postoperative hematoma was noted. This rate of 0.8 per cent for this complication per number of cases and 0.7 per cent per number of wounds appears to be unduly low. For an explanation, it is fair to assume that in many other instances hematomas occurred, became contaminated, and were subsequently recorded as infections. The frequency of hematomas in cases of single hernia was 1.1 per cent, in bilateral hernia 1 per cent by cases and 0.5 per cent by wounds. There was no instance of hematoma in both wounds in any case of bilateral hernia. The rate of hematomas by decades of life was first, 0; second, 0.6 per cent, third, 0.5 per cent; fourth, 1.3 per cent, fifth, 1.3 per cent, sixth, 0.8 per cent, and over 60, 1.1 per cent. With the use of catgut or silk as suture material, the frequency of this complication was 0.8 per cent and 0.9 per cent, respectively, kangaroo tendon or ox fascia, 1.3 per cent, and autogenous fascia, 0. Only 0.7 per cent of the cases in which general or spinal anesthetics were used were complicated by hematoma, while 1.2 per cent of those in which a local anesthesia was used were so complicated.

There was a total of 99 cases of wound infection, 4.9 per cent per number of cases and 4 per cent per number of operative wounds. We have divided the wound infections into three groups, according to their severity. (A) Superficial infections, stitch abscesses or infections occurring on a raw surface, the result

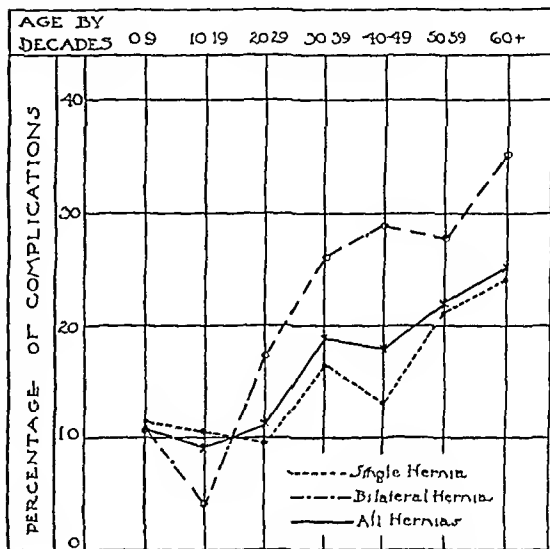


Chart 1 Age group—all types of complications

of improper coaptation of the wound edges, (B) moderate infections, in which the subcutaneous tissue was involved but the hospital stay of the patient was not prolonged, (C) deep infections, in which the deeper tissues were involved, causing slough and prolonged hospitalization of the patient.

There were 53 cases of superficial infection (2.6 per cent). Thirty of these were in patients operated upon for single hernia, 2 per cent of the 1,508 cases, and 23 were in the group of 492 individuals with bilateral hernia, a rate of 4.7 per cent of infection. The moderate infections, 11 in number, for single hernia showed a rate of 0.7 per cent and for bilateral hernia, 4 in number, a rate of 0.8 per cent. The number of deep infections for the single hernia was 18, a rate of 1.2 per cent, and for the bilateral, 13, 2.6 per cent.

The rate by cases for moderate and deep infections was 2.3 per cent, in the group of cases of bilateral hernia it was 3.4 per cent. This was nearly double the rate for the cases of single hernia, which was 1.9 per cent. However, if figured by wounds, the rate for all wounds was 1.8 per cent. It was slightly less in cases of bilateral hernia than in those of single (29 infections in 1,508 wounds of single hernias, 1.9 per cent, and 17 infections in 984 wounds of bilateral hernias, 1.7 per cent).

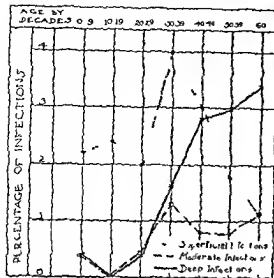


Chart 2 Age group—types of infections

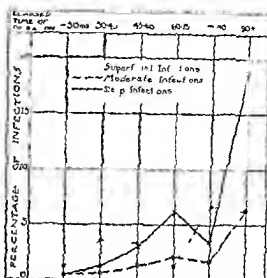


Chart 3 Infections in relation to time length of operation

The superficial infections in cases of single and bilateral hernia showed much the same relationship, 2 per cent for the single and 2.3 per cent for the bilateral.

An analysis of cases by age groups (Chart 2) showed a rate of less than 0.2 per cent for the moderate and deep infections during the first three decades of life, the rate then increased. The deep infections continued to increase each succeeding decade, reaching a maximum of 3.4 per cent in persons over 60 years of age. The rate of moderate infections, after the thirtieth year rose to around 1 per cent, where it remained during the later years. The rate of superficial infections appeared to be higher in younger persons, a little above 2 per cent, during the first three decades, it then rose to 4 per cent during the fourth decade and, finally, declined, being lower each succeeding decade, finally reaching 1 per cent in persons over 60. Studied by the number of wounds, the rates by age were slightly lower, the curve of the graph though similar in form to Chart 2, shows, however, lower percentage values.

Wound infection was studied in reference to the elapsed time of operation. It was found that in the cases of both single and bilateral hernia there was an increase in the rate of infection in all types, superficial, moderate and

deep, in direct relationship to the length of time of operation (Chart 3). This, as can be seen, is most marked in the case of deep infection, in which the rate rises to a maximum of 18.7 per cent after 1 1/2 hours of elapsed operation time. By combining the moderate and deep infection rates and analyzing them in relation to elapsed time of operation, it is found that the rise of the infection rate in the case of single hernia occurred after a shorter period of elapsed operation time and rose more abruptly as this time lengthened, than in the case of the curve of the bilateral hernia (Chart 4).

Table II gives the data of wound infections in relation to the type of anesthesia that was used. The highest rate of wound infection per cases (3.6 per cent), as well as per wounds (2.7 per cent), occurred among the individuals on whom a spinal anesthesia was used. The rates of wound infection in the persons on whom general or local anesthetics were used were about equal, the latter being slightly lower (general anesthesia by cases 2.4 per cent and by wounds 1.7 per cent, local, by cases 1.8 per cent and by wounds 1.5 per cent).

Catgut was used in 1,529 cases or in 1,903 wounds, silk in 326 cases or 395 wounds, kangaroo tendon or fascia in 73 cases, or 90 wounds, and autogenous fascia in 72 cases, or

102 wounds Chart 5 shows the percentage rate of all types of infections by cases, when these different kinds of material were used.

The lowest rate of infection occurred among individuals operated upon with the use of silk (2.7 per cent by cases, 2.3 per cent by wounds) Those with catgut were next in frequency (4.9 per cent by cases, 3.9 per cent by wounds) This was followed by those in which kangaroo tendon or ox fascia was used (6.8 per cent by cases, 5.6 per cent by wounds) By far the highest rate of infection was in those cases in which autogenous fascia was used as the suture material (13.8 per cent by cases, 9.8 per cent by wounds).

Not only were there marked differences in the rates of moderate and deep infections, in relation to the different kinds of suture material that were used, but also in the case of the superficial ones. This last type occurred in the following order of frequency according to the type of suture material that was used kangaroo tendon or ox fascia, 1.3 per cent; silk, 1.5 per cent; catgut, 2.8 per cent, and autogenous fascia, 5.5 per cent

Grouping the moderate and deep infections together, the order of frequency of infection in relation to suture material was silk (by cases 1.2 per cent, by wounds 1 per cent), catgut (by cases 2.1 per cent, by wounds 1.7 per cent, kangaroo tendon or ox fascia (by cases 5.5 per cent, by wounds 4.4 per cent) and autogenous fascia (by cases 8.3 per cent, by wounds 6 per cent) With the use of each type of material the rate of infection in the cases of bilateral hernia was twice that of single, except in the cases in which silk was used as suture material.

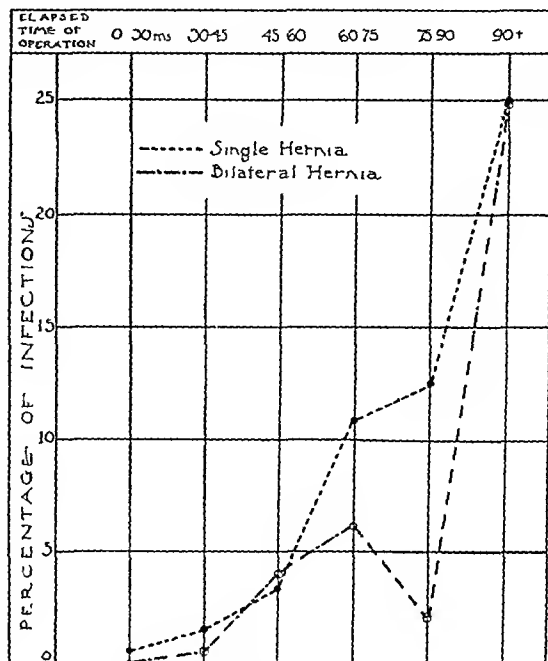


Chart 4 Moderate and deep infections in single and double hernias in relation to time length of operation

There were 171 (8.6 per cent) cases of respiratory complications following operation; only 71 (3.5 per cent) were of a serious nature, 46 cases of atelectasis (2.3 per cent); 13 cases of pneumonia (0.7 per cent); and 12 cases of pulmonary embolus (0.6 per cent). There were 21 cases of upper respiratory infections (1.1 per cent), 77 (3.8 per cent) of severe cough without any demonstrable lesion, and 2 (0.1 per cent) of bronchitis. Those operated upon for bilateral hernia showed a much higher frequency of respiratory complications

TABLE II—WOUND INFECTIONS IN RELATION TO ANESTHESIA

Types of anesthesia	Single hernias			Bilateral hernias			Total hernias			Wounds of bilateral hernias			Total wounds		
	Cases	Infections		Cases	Infections		Cases	Infections		No of wounds	Infections		No of wounds	Infections	
		No	%		No	%		No	%		No	%		No	%
General	777	14	1.8	236	7	3	1013	21	2.4	472	7	1.5	1249	21	1.7
Spinal	279	9	3.2	138	6	4.3	417	15	3.6	276	6	2.2	555	15	2.7
Local	452	6	1.3	128	4	3.4	579	10	1.8	236	4	1.7	683	10	1.5
Total anesthetics	1508	29	1.9	402	17	4.4	2000	46	2.3	984	17	1.7	2402	46	1.8

Number of moderate and deep infections in relation to different types of anesthesia

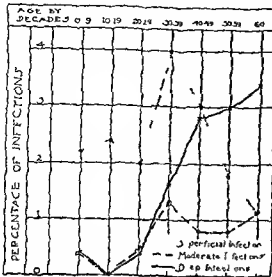


Chart 2 Age group—types of infections

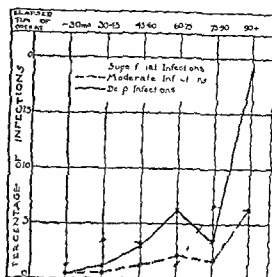


Chart 3 Infections in relation to time length of operation

The superficial infections in cases of single and bilateral hernia showed much the same relationship, 2 per cent for the single and 2.3 per cent for the bilateral.

An analysis of cases by age groups (Chart 2) showed a rate of less than 0.2 per cent for the moderate and deep infections during the first three decades of life; the rate then increased. The deep infections continued to increase each succeeding decade, reaching a maximum of 3.4 per cent in persons over 60 years of age. The rate of moderate infections, after the thirtieth year, rose to around 1 per cent, where it remained during the later years. The rate of superficial infections appeared to be higher in younger persons, a little above 2 per cent, during the first three decades, it then rose to 4 per cent during the fourth decade and finally declined, being lower each succeeding decade, finally reaching 1 per cent in persons over 60. Studied by the number of wounds, the rates by age were slightly lower, the curve of the graph though similar in form to Chart 2, shows, however, lower percentage values.

Wound infection was studied in reference to the elapsed time of operation. It was found that in the cases of both single and bilateral hernia there was an increase in the rate of infection in all types, superficial, moderate and

deep in direct relationship to the length of time of operation (Chart 3). This, as can be seen, is most marked in the case of deep infection, in which the rate rises to a maximum of 18.7 per cent after 1½ hours of elapsed operation time. By combining the moderate and deep infection rates and analyzing them in relation to elapsed time of operation, it is found that the rise of the infection rate in the case of single hernia occurred after a shorter period of elapsed operation time and rose more abruptly as this time lengthened than in the case of the curve of the bilateral hernia (Chart 4).

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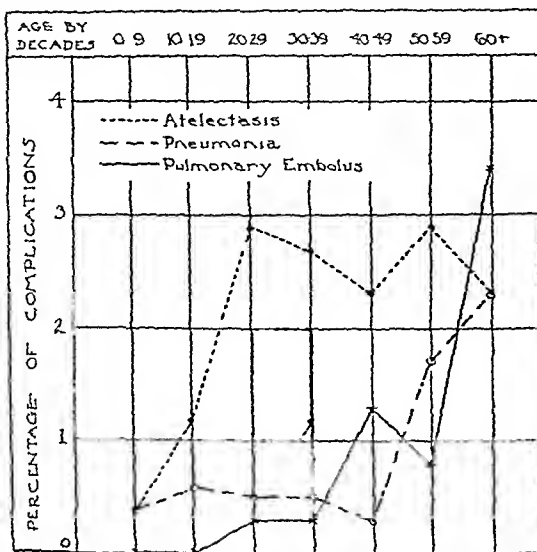


Chart 6 Respiratory complications in relation to age

there were 23 complicated cases, 15.9 per cent. Seventy-five operations took over 75 minutes, complications followed in 5 cases, 6.7 per cent. The frequency of the mild types of respiratory infection conformed to this rule, as well as the more severe. Only in the case of pulmonary embolus was there any variation.

The frequency of atelectasis as a postoperative complication in 1,780 cases in which operations were performed in less than 60 minutes was 2 per cent, in 220 cases in which the operation took over 60 minutes, the frequency was 5 per cent (Chart 7). The rate of frequency of pneumonia in the first group was 0.6 per cent and in the second 1.4 per cent.

The incidence of pulmonary embolus, when analyzed in its relationship to the elapsed time of operation, did not conform to those of the other types of respiratory complication. The rate of frequency rose from 0.4 per cent for individuals whose operations took less than 30 minutes, to a maximum of 0.9 per cent when the operations were performed in from 45 to 60 minutes, and then fell to zero when the time was longer than 75 minutes (Chart 7).

General anesthesia (ether, nitrous oxide, ethylene or a combination of one of the gases with ether) was used in 1,013 cases; spinal anesthesia (novocain) was used in 417; and

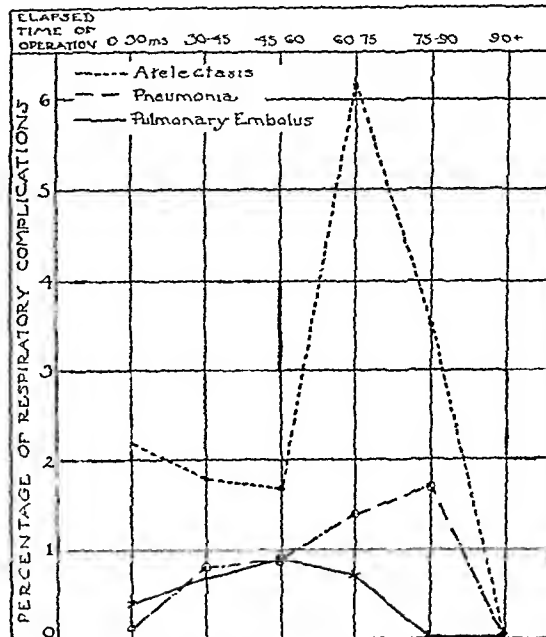


Chart 7 Respiratory complications in relation to time length of operation

local (novocain) in 570 cases. There were 74 (7.3 per cent) cases of respiratory complication following general anesthesia; 38 (9.1 per cent) following spinal anesthesia; and 59 (10.3 per cent) following local.

Cases of upper respiratory infection and of unexplained cough occurred with almost equal frequency regardless of what type of anesthesia was used.

Atelectasis followed in 3.4 per cent of the cases in which spinal anesthesia was used, 3.3 per cent in which local was used, and only 1.3 per cent in which general anesthesia was used. Pneumonia, on the other hand, appeared most frequently after general anesthesia, 1 per cent; and 0.2 per cent and 0.4 per cent, respectively, for spinal and local anesthetics.

The frequency of pulmonary embolus as a postoperative complication appeared more frequently when a local anesthesia was used (0.9 per cent); the frequency for spinal (0.2 per cent) and general (0.5 per cent) anesthesia was less in both cases when an analysis is made of the entire series. However, if the 394 cases of individuals under the age of 20 years are eliminated, as no case of pulmonary



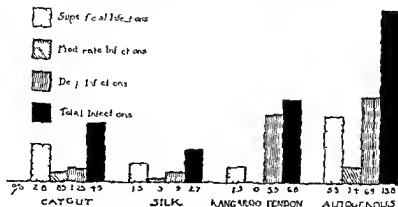


Chart 5 Wound infections in relation to suture material

than those for single hernia, 12.6 per cent and 6.7 per cent, respectively. This difference, however, is not apparent in persons under 20 years of age, in whom the more common complication were more often the mild types of infections which were equally distributed in the younger and older groups. The frequency of atelectasis following operation in the cases of single hernia was 2 per cent and for bilateral hernia 3.2 per cent. pneumonia followed operation for single hernia at a frequency of 0.5 per cent and in that of bilateral at 1.2 per cent. Pulmonary embolus however, followed operation for single hernia more often than for bilateral hernia (0.7 per cent for former, 0.2 per cent for latter).

Taking the number of respiratory complications as a whole, their frequency did not appear to be affected by the age of the patient. Individually, however, the age of the patient apparently played some part in the rate of occurrence. Upper respiratory infections occurred in 7 (3.1 per cent) of the 228 children, but in only 14 (0.8 per cent) of the 1,772 older individuals. The frequency of postoperative cough increased in proportion to the age of the individuals by decades.

Cases of atelectasis appeared during all the decades of life (Chart 6), the rate was lowest during the first 2 (0.4 per cent and 1.2 per cent, respectively) and remained the same (2.7 per cent) in the succeeding ones.

Pneumonia was more common in the aged (Chart 6), occurring in 6 instances (1.9 per

cent) in 325 cases of individuals older than 49 years and in but 7 instances (0.4 per cent) in 1,675 cases of persons who were younger than 50 years. Two individuals died from postoperative pneumonia (15.4 per cent), each was over 50 years of age.

There was not a single case of pulmonary embolus in the 394 patients under 20 years of age (Chart 6), an incidence of 0.3 per cent occurred during the third and fourth decades which increased to 1.3 per cent during the fifth then fell to 0.8 per cent in the sixth and finally reached a high of 3.4 per cent in persons over 59 years of age. There were 3 deaths in this group (25 per cent), 1 of these individuals was in his fifth decade of life and the other 2 were over 60 years of age.

The study of respiratory complications, in relation to elapsed time of operation (Chart 7), showed a definite increase in the morbidity for each succeeding period of time up to 75 minutes and from there onward a decrease in the frequency. However in the latter group there were only 75 cases—perhaps too few to obtain a true value. There were 1,440 operations which were performed on an average of under 45 minutes in these there were 110 cases with complications 7.6 per cent. Three hundred and forty operations were done in an average time of between 45 and 60 minutes, 33 of these individuals had complications, a rate of 9.7 per cent. One hundred and five operations were finished in an average period of time of 60 to 75 minutes, in this group

less uniformly through all the decades of life. Mild types of upper respiratory infection were frequently encountered in the children and young adults. The more serious complications, however, were found more often in the older individuals, their frequency increasing as age advanced (Chart 6). Atelectasis was relatively uncommon in those under 20 years of age, after this it was equally frequent in each succeeding decade. Pneumonia appeared equally as often in each of the first five decades of life and then its frequency increased rapidly during the succeeding years. No cases of pulmonary embolus occurred during first twenty years of life, but from then on there was a decided increase by decades.

*Elapsed time of operation.* The period of time used in performing the operation played an important part in the rate of frequency of both wound infection and severe respiratory complications. The frequency of all types of wound infection increased as the elapsed time of operation was lengthened. This was, however, most evident in the cases of moderate and deep infection (Chart 3). The curve for these types of infection rose rapidly from less than 0.5 per cent, for a 30 minute period, to 25 per cent, when the operation took longer than 1½ hours to perform. The curve is much the same for cases of both single and bilateral hernia, though, as would be expected, the rise of the curve for the latter type of case lags slightly behind the former (Chart 4).

Respiratory complications occurred more frequently as the period of time for operation was lengthened. This was evident in the mild types of upper respiratory infection, as well as the more serious pulmonary complications. Under a period of one hour, the frequency of atelectasis remained about 2 per cent and then rapidly rose. The frequency of pneumonia increased in proportion to the length of elapsed time of operation (Chart 7). (Both of these curves fell to zero when the time was longer than 90 minutes. However, this may have been due to the small number of cases in this group, only 16.) The curve for the frequency of cases of pulmonary embolus rose from a low in the shortest period of time,

reached its high when the elapsed time of operation was between 45 minutes and 1 hour, and returned to zero when the time was under an hour and a quarter.

*Anesthesia.* The morbidity from wound infection was slightly lower in those cases in which a local anesthesia was used (Table II), that for general anesthesia was a quarter again as high, and that for spinal twice that for local anesthesia. Considering the rate of frequency in relation to the wounds, that of general and local anesthesia was about equal and a third less than that of spinal.

The type of anesthesia which was used did not affect morbidity from mild upper respiratory infections. However, it did appear to affect that from the more serious pulmonary complications. Atelectasis appeared almost twice as frequently when local or spinal anesthesia was used, as it did when a general anesthesia was used.

Pneumonia, on the other hand, occurred more than twice as often following the use of general anesthesia. Pulmonary embolus appeared as a complication one-third as often following spinal anesthesia, as it did following either general or local anesthetics.

*Suture material.* The frequency of wound infection following the use of silk was nearly one-half that of catgut, one-third that of kangaroo tendon or ox fascia, and one-fifth that of autogenous fascia (Chart 5).

The more serious pulmonary complications occurred about twice as often among those cases in which kangaroo tendon or ox fascia or autogenous fascia were used, as among those in which silk or catgut were used.

#### SUMMARY

The immediate postoperative complications in a series of 2,000 cases of simple oblique and direct inguinal hernias have been analyzed. This analysis has been made in relation to whether the individual had a single or bilateral hernia and as to sex, age of the patient, and elapsed time of operation, the type of anesthesia used, and the kind of suture material that was employed at operation. Seven graphs illustrate these complications.

embolus appeared among them and as the majority (91 per cent) received general anesthesia, the frequency of this complication, in relation to the type of anesthesia that was used, becomes changed. Under this change it is found that in the cases in which local or general anesthesia were used, in each instance pulmonary embolus appeared at a frequency of 0.9 per cent, while with spinal anesthesia it was only 0.2 per cent.

Comparing the frequency of atelectasis, pneumonia, and pulmonary embolus as post operative complications, to the type of suture material employed, the 1,606 cases of persons over 19 years of age have been used for this analysis as it is believed a fairer conclusion can be reached, as in the younger group of individuals kangaroo tendon, or fascia, and autogenous fascia were seldom used and because these complications were infrequent under the age of 20 years. These pulmonary complications were found to be higher in frequency when kangaroo tendon or or fascia (7.6 per cent) and autogenous fascia (7.1 per cent) were employed, than when catgut (3.7 per cent) or silk (4.4 per cent) were used as suture material. The frequency of atelectasis was 2.4, 3, 3, and 5.9 per cent in the use of catgut, silk, kangaroo tendon or or fascia and autogenous fascia, in the order given. The frequency of pneumonia was 0.4, 1, 3, and 1.4 per cent, in the above order, and pulmonary embolus was 0.9, 0.3, 1.5 and 0 per cent.

Thrombophlebitis was a complication in 0 cases, 3 of single hernia (0.2 per cent) and 3 of bilateral (0.6 per cent). The frequency did not appear to be affected by the type of anesthesia or the kind of suture material.

#### CONCLUSIONS

Any conclusion that may be drawn from a statistical report is open to correction and should not be considered as final. The opportunities for the occurrence of erroneous conclusions are many. The greatest of these is the inability to study a large enough series of cases, so that the smaller groups may contain a sufficient number to obtain true values. Further, erroneous conclusions are bound to occur when there are multiple factors to be considered in obtaining results, as it is often

impossible to separate the true elements that contribute to a given conclusion from the others that may be present. This study of a series of 2,000 cases of simple inguinal hernia, in which the immediate postoperative results are analyzed, is open to both of these objections. However, it is believed that the conclusions that are drawn are of sufficient value to publish, in the hope that later others may add their experiences to ours.

**Bilateral hernia.** The risk of complications in operations for bilateral inguinal hernia was nearly twice that of single hernia. During the first two decades of life this danger was not evident, but in each subsequent one the postoperative morbidity in the case of bilateral hernia was far greater than in the case of single (Chart 1).

Wound infection occurred more than twice as often in cases of bilateral hernia. This ratio was manifested in the group of mild or superficial infections as well as in those of the moderate and deep types. However, if studied by wounds, infection was as frequent in those of single hernia as of bilateral.

The risk of respiratory complications in the cases of bilateral was much greater than in the cases of single hernia. Both atelectasis and pneumonia followed operation twice as often in the former group as they did in the latter. Pulmonary embolus, however, followed operation twice as often in cases of single hernia. Thrombophlebitis was more commonly observed among the cases in the bilateral group.

**Age.** The age of the patient was an important factor in relation to the rate of morbidity (Chart 1). Up to 30 years of age, complications were relatively infrequent, from then on there was a steady rise in their frequency in each succeeding decade.

The frequency of cases of mild or superficial wound infection apparently was not affected by age, but the frequency of cases of moderate and deep infection, which remained uniformly low during the first three decades of life, rose rapidly in proportion to the age of the patient during the later decades (Chart 2).

The frequency of respiratory complications taken as a whole, were distributed more or

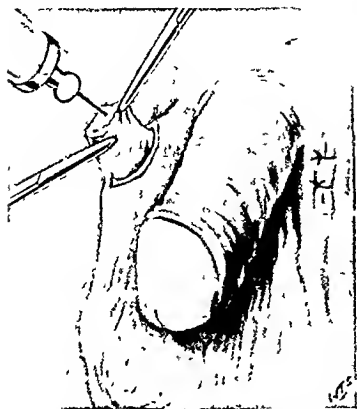


Fig 1 Drawing to show the vas deferens exposed and divided in the upper part of the scrotum. A hypodermic needle has been inserted into the proximal end for irrigation of the seminal vesicle with 1:80 carbolic acid.



Fig 2 Roentgenogram of the left vas deferens, the left seminal vesicle and the prostatic urethra outlined by sodium iodide which has been injected into the lumen of the vas just below the external abdominal ring. The shadow above the seminal vesicle represents an excess of sodium iodide which has flowed back from the prostatic urethra into the bladder.

is rapidly sealed by scar tissue. The patient is now placed in the Trendelenburg position and the surgeon proceeds to expose the bladder by a sub-umbilical incision. The fluid contents are evacuated by a special trocar and cannula which acts by suction. The appearance of the internal meatus, in cases of adenomatous disease of the prostate is always instructive, therefore visualization of the internal meatus, though not an essential part of the technique, is an aid to understanding of the causes at work which produce retention. It is also helpful in determining why the patient develops residual urine in these cases. With patients in whom a large amount of residual urine is present the internal meatus may have been pushed forward so far by the developing adenomatous mass that it lies within an inch of the anterior wall of the bladder.

The pathological mass of adenomatous tissue is then enucleated from within the prostatic bed by the intra-urethral method. The finger is inserted into the internal meatus and the mucous membrane is ruptured. The finger is swept round the tumor which is easily separated from the surrounding glandular tissue. The urethra is then fractured as near to the verumontanum as is possible. The amount of urethra left behind proximal to the triangular ligament is dependent upon the extent of the growth. If the whole of the prostatic portion is surrounded by adenomas, the fracture occurs at the point where the urethra passes through the triangular ligament. On the other hand, if the main mass is intravesical, a considerable length of prostatic urethra can be left behind.

The surgeon, after the pathological mass has been removed, then inserts into the bladder the special illuminated retractors (Fig 3), to each

fenestrated blade of which is attached a small electric lamp. The blade which retracts the posterosuperior wall of the bladder is so shaped that it not only retracts this part of the bladder but also the base. With the aid of these three lamps the interior of the bladder is so well flood lighted that a perfect view is obtained of every detail, excluding, of course, the prostatic cavity.

After removal of any clots which have collected in the operation area, the illuminated anterior retractor (Figs 4 and 5) together with the prostatic speculum is inserted into the prostatic cavity (Figs 6 and 7). The blades of the speculum not only act as retractors by opening up the entrance to the prostatic cavity, but also by their pressure upon the lateral walls function as temporary hemostats. The prostatic cavity is flood lighted by two tiny lamps attached to the anterior retractor, within the handle of this instrument is a three voltage dry cell battery. The prostatic cavity is so well visualized by this instrument that it is possible not only to see the floor of the cavity but also the prostatic surface of the triangular ligament with the protruding torn portion of the prostatic urethra (Fig 9). The trigonal flap of the mucous membrane is now stitched if possible to the mucous membrane of the urethra. If this is not possible because of the extent of prostatic urethra removed by enucleation, the flap is stitched as near the triangular ligament as is possible. The stitching is done with the aid of the boomerang

# CLINICAL SURGERY

FROM ST PETER'S HOSPITAL FOR URINARY DISEASES

## THE RECONSTRUCTION OPERATION FOR ADENOMATOUS DISEASE OF THE PROSTATE

CLIFFORD MORSON OBE FRCS (Eng), London, England

THE surgeon who designs an operation intended to restore an organ to its normal anatomical and physiological states following the removal of diseased tissues which have caused dysfunction must be guided by the following principles (1) hemorrhage must be under complete control, (2) sepsis must be avoided and (3) tissues which have been divided must be brought together again in correct alignment. These are well known principles which the medical profession has put into practice since the introduction of antiseptic and aseptic surgery but until recent date they have been considered impossible of achievement in operations on the prostate gland. The anatomical position of the organ and the frequent presence of chronic sepsis have led surgeons to believe that they cannot carry out in this region of the body the technique which embodies the principles taught them from their student days.

Today the introduction of flood lighting in a body cavity and the invention of instruments designed to overcome successfully an operator's difficulties with manipulation of deep seated tissues have placed the technique of prostatectomy on an equality with that of the surgery of any other organ. The pioneer surgeons of successful prostatectomy showed fine courage and tenacity of purpose against severe criticism, but it was a crude operation. The procedure was a blind one. The open operation which replaced it in 1916 was an attempt under direct vision to control hemorrhage and sepsis. Reconstruction was looked upon as an idle dream.

The purpose of this article is to describe a technique which under certain conditions makes reconstruction following total removal of adenomas of the prostate a successful operation.

For this technique the pre operative preparation is similar to that for any other operation upon the prostate gland. The tests for determining renal function to all intents and purposes are now

standardized and exact but we have yet to find some method which will measure with accuracy the resistance to infection of the kidneys following upon these operations. At one time it was hoped that the estimation of the blood cholesterol would help to solve this problem but experience has shown that no reliance can be placed on it.

**Anesthesia.** Ether anesthesia is employed in all cases with induction by gas and oxygen. In very nervous patients a small dose of sodium evipan, sufficient to produce unconsciousness for 10 minutes, is given intravenously before the patient is transferred from his bed to the anesthetic room. Spinal anesthesia is not recommended. Relaxation by inhalation ether is just as satisfactory as by a drug injected into the spinal theca, for the lowering of blood pressure associated with spinal anesthesia is a distinct disadvantage. Lung complications also are not ruled out by this method of anesthesia administration.

As soon as the patient has been placed upon the operating table, a catheter is passed and the bladder is washed out with 1,000 c.c. of a 1% mercuric iodine solution. The organ is then distended with about 10 ounces of this solution. The surgeon now proceeds to dissect out the vas deferens immediately below the external abdominal ring and divide it (Fig. 1). Through the proximal end of the cut vas a blunt hypodermic needle is passed into its lumen and with a syringe 10 cubic centimeters of a solution of 1:80 carbolic acid are injected into the seminal vesicle (Fig. 2). The object of division of the vas is to prevent epididymo-orchitis and by irrigating the seminal vesicles before the bladder is opened we ensure sterilization of these organs. In patients who have submitted to pre-operative bladder drainage by a tied in catheter, vesiculitis is extremely common. Irrigation, therefore, of these organs removes bacteria which have gained access through the irritation caused by the indwelling catheter. There is no need to ligature the divided ends of the vas deferens for the lumen

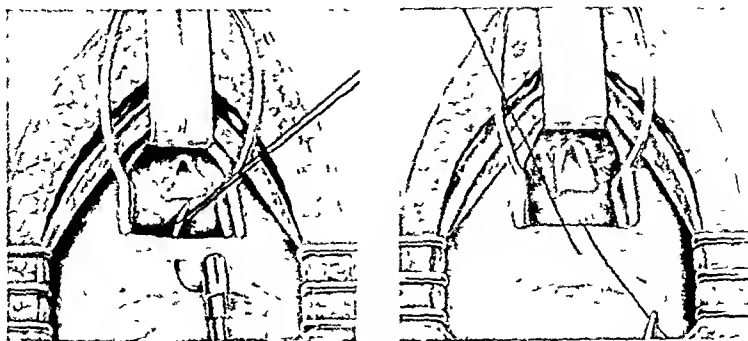


Fig 6, left The anterior illuminated retractor with the prostatic speculum is seen in position. The prostatic bed and the torn end of the prostatic urethra are visualized. The boomerang needle has been passed through the mucous membrane of the trigonal flap and the catgut suture has been attached to it.

Fig 7 A drawing to show the first maneuver of the trigonal flap suture.

cases a small angular White's tube suffices to assist in bladder drainage. It is essential, when primary closure is practiced, to drain the prevesical space by means of a corrugated rubber wick. Slight leakage of urine always occurs into this space, but will cause no trouble if there is a vent for its escape. Lastly, the ends of the silkworm gut suture which maintains the catheter in its correct position are immobilized by metal buttons of the Emesay pattern (Fig 14).

Before the patient's return to bed the bladder should be irrigated through the catheter. If hemorrhage has been efficiently controlled, the return of fluid will be scarcely blood stained.

Immediately the patient is returned to the ward, the head of his bed is raised about two feet from the ground. Not only does this position assist drainage from the bladder, but it adds enormously to the comfort of the patient. The catheter (Fig 15) is attached to a special glass urinal which lies between the patient's thighs. It is instructive to note how little discomfort is caused by the presence of a soft rubber catheter in the urethra, maintained in position by the technique which has just been described. The catheter in the urethra strapped to the penis is a form of torture which is entirely dispensed with by this method of fixation. It is an important step forward in adding to the patient's comfort during postoperative convalescence. The degree of urethritis is negligible and the catheter, so long as the silkworm gut suture is intact, never alters its position, however much it may be dragged on.

A convalescence free from complications is largely dependent upon efficient after-treatment. By elevating the head of the bed better bladder drainage, via the catheter, is assured. For the

first 24 hours, the bladder must be irrigated through the catheter, at intervals of 2 hours, with not more than 2 ounces of a solution of 1:8000 oxycyanide of mercury at a temperature of 90 degrees F. For the first few days after operation, the bladder is intolerant of distention by more than 2 or 3 ounces. It is for this reason that care must be taken not to inject more than this amount each time. If primary closure has been practiced, it is advisable to irrigate every hour for the first day. Sometimes a small clot will block the catheter, this can be easily removed by using the syringe as a suction apparatus.

The day following operation the irrigation should be reduced to four hourly. The necessity for using a solution at a temperature of not more than 90 degrees F. is apparent, if one realizes how sensitive the bladder mucous membrane is to heat, also fluid of a temperature above body heat is likely to increase the oozing of blood. The urine remains

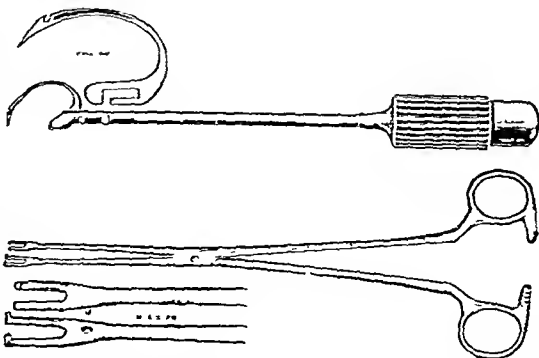


Fig 8 The boomerang needle. Special instrument used for threading boomerang needle.

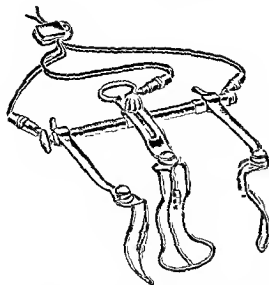


Fig. 3 The special illuminated bladder retractor

needle. Because of the tendency of the trigonal flap to retract when a Lambert suture is used, a special stitch, as shown in the illustration, is adopted. Care must be taken that the boomerang needle (Fig. 8) is inserted only through the trigonal flap and the superficial tissues forming the prostatic bed (Fig. 20). There is no need to insert the needle deeply into these tissues for all that is required is to bind down the mucous membrane of the trigone to the floor of the prostatic cavity. The criticism which has been made that the point of the needle may be inserted too deeply can be justified only if the operator is ignorant of the principles involved in this operation. As soon as this stitch has been tied (Fig. 11), a soft rubber catheter of the Malascot type, No. 22 French in size and with two eyes, is inserted by means of an introducer through the urethra and prostatic cavity

into the bladder. This catheter should be about 15 inches in length. The catheter is now drawn out through the bladder wound, the mushroom end is cut off and a silk worm gut suture is passed through it immediately distal to the second eye. This is the suture which will retain the catheter in its correct position.

The operator now proceeds to reconstruct the internal meatus by means of a figure of eight stitch (Fig. 11). This is inserted into the mucous membrane and submucous tissues which form the lateral walls of the prostatic cavity, on no account should this suture be inserted into the tissues external to the flaps. Figure 11 shows clearly how this suture is inserted. It has a twofold purpose: (1) reconstruction as already stated, and (2) to act as a hemostat. The reconstruction part of the operation is now complete. The catheter is placed in position so that both eyes are within the bladder. Before the retractors are removed all clots must be swabbed out from the bladder and the new internal meatus visualized. The latter has two striking features: first it is on a level with the base of the bladder thus entirely obliterating the post prostatic pouch and second, it closely resembles the appearance of the internal meatus in a normal bladder. The surgeon now proceeds to pass the silk worm gut suture (Fig. 13) holding the catheter in position through the bladder and abdominal walls and out through the skin. Care must be taken not to puncture the deep epigastric vessels with the needle by keeping close to the cut edges of the skin.

The next step is to close the anterior wall of the bladder, but primary closure must be practiced only if the urine before the operation is sterile and the surgeon is sure that he has controlled the bleeding of the lateral walls of the prostatic cavity (Fig. 13). Therefore the contra indications for primary closure are infective pyelonephritis, severe cystitis and inadequate hemostasis. In these

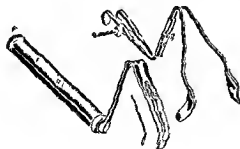


Fig. 4 Anterior bladder retractor with prostatic specimen unattached

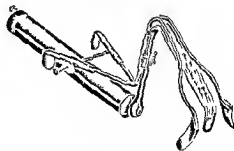


Fig. 5 Prostatic specimen attached to anterior bladder retractor

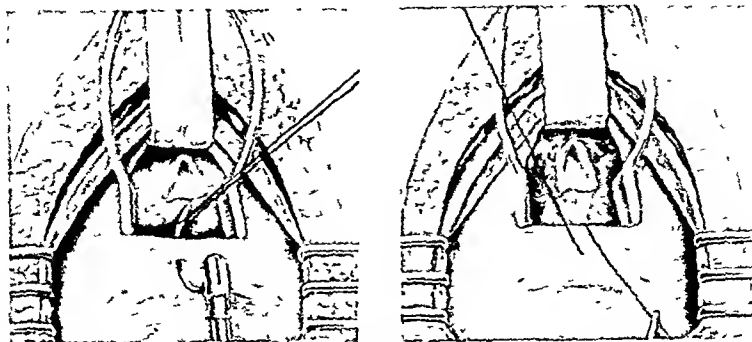


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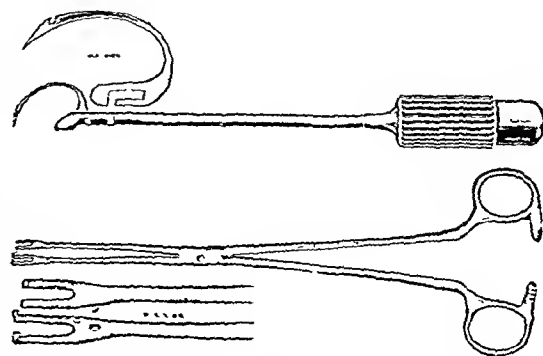


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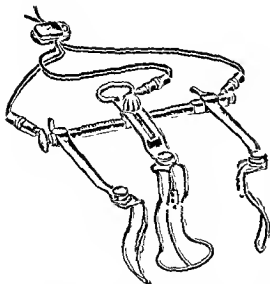


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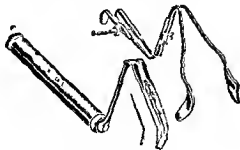


Fig. 4 Anterior bladder retractor with prostatic speculum unattached

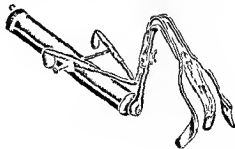


Fig. 5 Prostatic speculum attached to anterior bladder retractor

until the sixth week. It was found that the healing process in this region was extremely slow. Even at the end of the sixth week there was still non-union between the mucous membrane of the trigone and that of the urethra. So long as a raw surface persists there must be pyuria. From 2 to 3 months, therefore, elapse before the tissues at the neck of the bladder, following prostatectomy, become normal, if there has been no attempt to cover up the raw surface of the prostatic bed by mucous membrane, as in the blind, or Freyer, operation, this healing process cannot be complete for at least 4 to 6 months. This accounts for the fact that if postprostatectomy obstruction is going to occur, it does not manifest itself for about 6 months following removal of the diseased prostate. We are satisfied that the large majority of patients are discharged from hospital long before healing is complete at the internal meatus. Posterior urethroscopic examination demonstrates quite clearly the importance of bringing the mucous membrane of the base of the bladder as near to the torn end of the prostatic urethra as is possible. The more extensive the area of raw surface uncovered at the time of operation, the greater will be the formation of scar tissue and, therefore, contraction at the bladder neck.

It must be understood that a reconstruction operation such as the writer has outlined in the previous pages can be performed only if it is possible to obtain adequate exposure of the bladder and, also, adequate visualization of the prostatic cavity. For both special retractors and powerful illumination are needed. In a few cases of a second stage prostatectomy, the bladder is so contracted that it is impossible to insert any form of retractor which will give sufficient exposure of the internal meatus without tearing the posterosuperior wall of the bladder and making an opening into the peritoneal cavity. It is obvious that, in this class of case, a reconstruction operation is out of the question.

What are the immediate results from this technique compared with those of the Freyer or blind operation, and the Judd-Thompson Walker open operation? It is found that a reconstruction operation shortens convalescence by about a fortnight

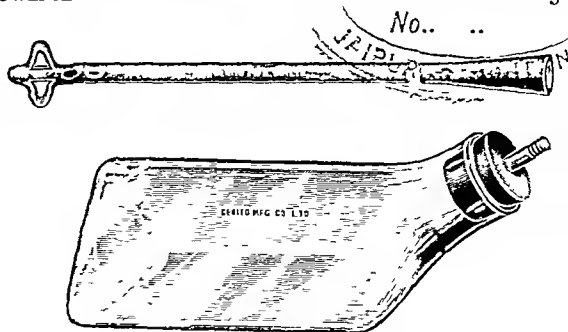


Fig 15 Catheter Glass urinal

This is particularly so when primary closure is practiced. Convalescence in those cases in which a small suprapubic tube is inserted is a little longer. Most noticeable of all the changes is the control of postoperative hemorrhage. The comfort of the patient in not having a large suprapubic tube discharging urine and blood and the absence of an Irving apparatus is too obvious to need emphasis.

The control of sepsis, however, is still an unsolved problem. Surgical interference with a diseased prostate, whether it be by an open operation or by transurethral resection, admits organisms to the bladder which flourish in the wound at the vesicle neck. The larger the raw surface, the greater the infection. It is claimed for the reconstruction operation that sepsis is less pronounced than in the older technique, because the major part of the prostatic bed is covered by mucous membrane. Postprostatectomy obstruction, a remote complication of the blind operation—the Judd-Thompson Walker open method, and transurethral resection—never occurs in the reconstruction technique. In fact, one of the most striking results is the ease with which urethral instruments such as the cystourethroscope can be passed.

Finally, it is stressed that in all those cases in which a complete cure for adenomatous disease of the prostate is indicated, the operation technique should be that described in this paper.

Many of the illustrations appearing in this article are reproduced by the courtesy of the Honorary Editors of *The Proceedings of the Royal Society of Medicine*.

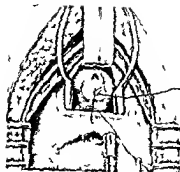


Fig 9

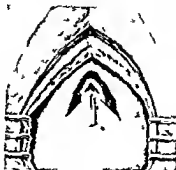


Fig 10



Fig 11

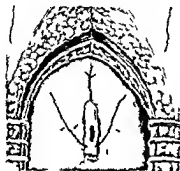


Fig 12



Fig 13

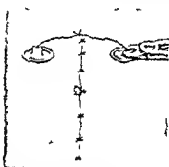


Fig 14

Fig 9. A drawing to show the second maneuver of the trigonal flap suture. The needle has been passed through the whole thickness of the trigonal flap, the prostatic tissue forming the bed and the torn mucous membrane of the urethra. The needle is threaded with the flap suture.

Fig 10. The trigonal flap suture has been tied. Note that retraction of the flap is impossible.

Fig 11. The urethral tube in position after the posterior anchoring stitch has been tied. The figure of eight suture has been inserted. The knots in the trigonal flap are incorrectly drawn and can be ignored.

Fig 12. The figure-of-eight suture has been used. A suture has been passed through the catheter, lateral walls of the bladder and abdominal wall. (The anchoring stitch for the urethral catheter.)

Fig 13. The anterior wall of the bladder completely sewed up. The anchoring stitch can be seen protruding through the skin of the abdominal wall.

Fig 14. Drawing to show the edges of the skin sutured together and the protruding corrugated rubber wick. On either side of the wound can be seen metal buttons which grip silkworm gut sutures holding catheter in position.

blood stained for about 3 days. If an angular White's tube has been inverted at the time of operation, it can be removed on the fourth or fifth day. The catheter remains *in situ* for 10 days. It is easily withdrawn by dividing the silkworm gut suture beneath one of the buttons. This suture is then pulled out with the aid of the other button.

If the prevesical space has been drained by means of a corrugated rubber wick, its retention is not needed for longer than 3 or 4 days.

Directly the catheter is removed, the patient passes urine by the urethra. For some days micturition is about two hourly but by the time the patient leaves the hospital on an average about the twenty fourth day micturition has become four hourly.

The abdominal wound should be securely healed within 3 weeks of the operation. In many cases the healing is complete by the fourteenth day. The extent of urine leakage when a White's angular tube has been inserted is so slight during the first few days after its removal that the dressing need be changed only once a day. In cases of primary closure of the bladder wall the abdominal wound heals by first intention. In every case of prostatectomy no matter what may be the technique, the urine on the patient's discharge from hospital contains pus and bacteria. The reason for this infection so long after the operation is easily explained.

An investigation was made by J. E. Semple and the writer with the aid of the posterior urethroscope of the changes which take place in the prostatic bed from the fifteenth day after operation.

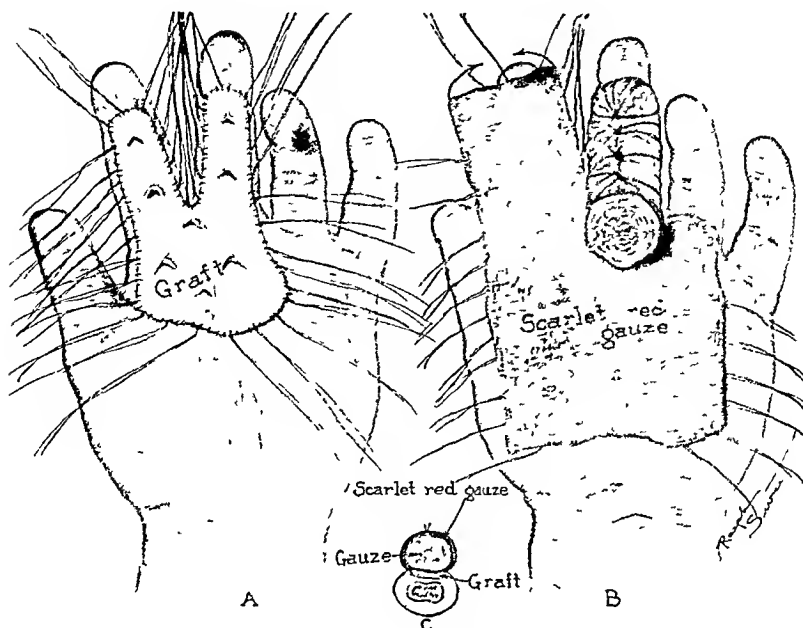


Fig 3 A, B, C, Application of tied in local pressure for Wolfe grafts

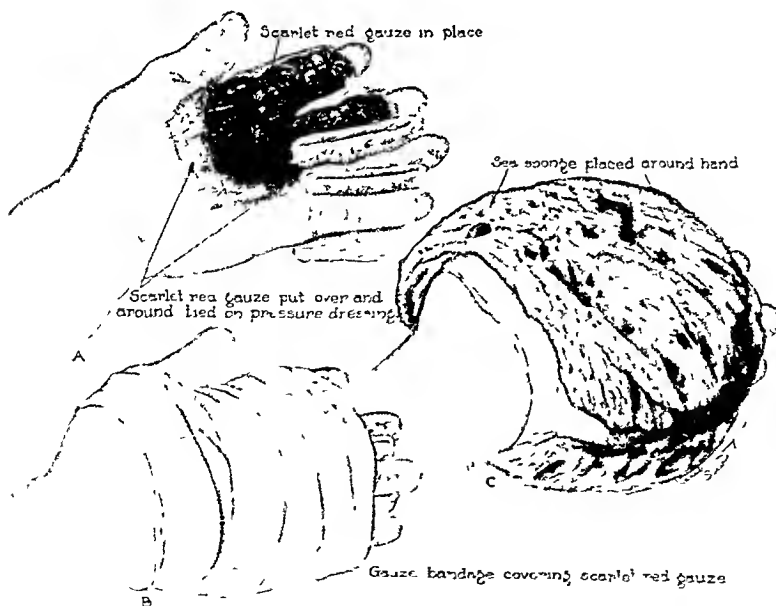
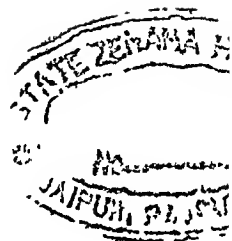


Fig 4 A, B, C, Further steps in application of pressure to Wolfe grafts

# BURN CONTRACTURES OF THE HAND

H M BLACKFIELD MD *San Francisco California*

**S**EVIRE burns of the hand and their sequelæ—loss of tissue, infection, scar tissue, and contractures—may so damage a hand that reconstructive surgery is of little or no avail. Early skin grafting will prevent these complications in many instances thereby eliminating the necessity for difficult and time consuming secondary reconstructive procedures.

During recent years after a group of early burns of the hand and late healed contractures

early unhealed cases the extent of the loss of tissue is usually recognized easily but in old healed cases this is not always true. One is frequently amazed at the degree of anatomical distortion which occurs simply as a result of the loss of skin. In the late cases the function of each anatomical structure must be carefully evaluated before the plan of repair is decided upon.

It has been found that the contracted joints of children and young adults if not directly involved

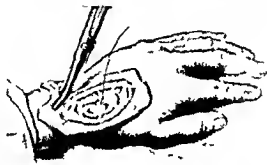


Fig 1 Method of suturing of split graft to hard defect



Fig 2 Method of applying pressure dressing to split graft

have been treated some definite conclusions have been reached. Based upon these experiences rules have been adopted to guide our management of burns of the hand and contractures following such burns.

The importance of a detailed examination of the injured member and a diagnosis of its altered anatomy cannot be stressed too strongly. In

by burns will usually return to normal function following the release of the contracture. For this reason contracted fingers in children should rarely be amputated. Elastic traction may be necessary for some weeks or months following grafting before the final result is achieved. This is particularly so if the contracture is of some years standing. A return to normal is not the rule in the later decades of life where changes in the joints and permanent loss of function are

From the Department of Surgery University of California Medical School

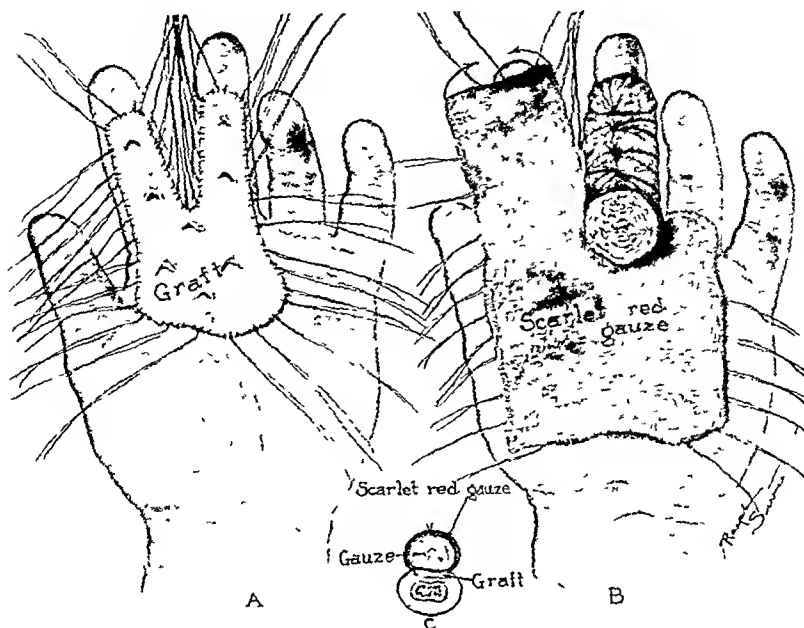


Fig 3 A, B, C, Application of tied in local pressure for Wolfe grafts

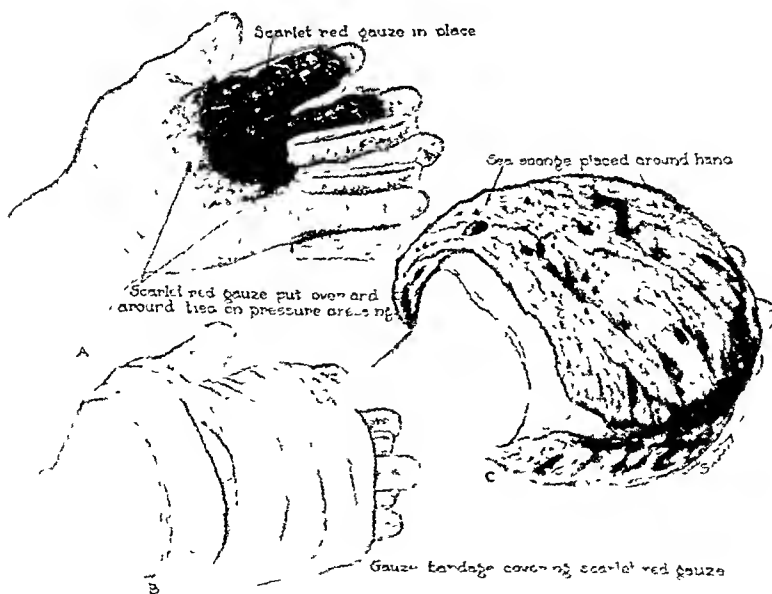


Fig 4 A, B, C, Further steps in application of pressure to Wolfe grafts

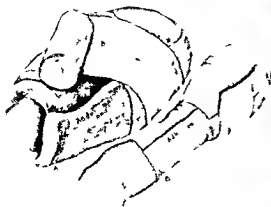


Fig 5 A B Final step in application of pressure to Wolfe grafts

frequently very marked following a short period of immobilization. In such cases the prognosis must be guarded.

#### SPLIT GRAFTS

The accepted types of skin grafts used in the conditions mentioned are (1) split skin graft or graft of intermediate thickness (Blair) (2) free full thickness skin graft (Wolfe) (3) dermo-subcutaneous pedicle flap.

The graft introduced and described by Blair comprises from one half to three quarters of the

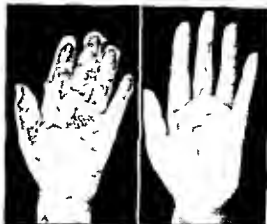


Fig 7 A Early case. No deep structures are involved. Laundry worker. Hand caught in hot mangle. Appearance of hand 4 weeks after burn. B Six weeks after split grafting.

thickness of the skin and may be obtained easily in large sheets by means of his suction boxes and knife. This graft is thicker than its predecessor, the Thiersch graft, contracts less and with stands trauma to a greater degree. In most instances it takes even though the field is not perfectly clean. Its greatest use is in the covering of granulating areas when deeper structures are not involved, particularly on the dorsum of the hand. In children suffering from the loss of large

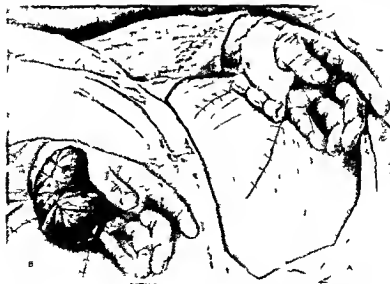


Fig 6 A B Application of tied in pressure principle for a pedicle flap

Fig 8 A, Early case Deep structures involved Glass worker Hand caught in machine B, Pedicle flap constructed in 2 stages C, Immobilization spica of sheet wadding, muslin, and adhesive More comfortable than plaster-of-paris D and E, Appearance of hand after completion of grafting



Fig 8

Fig 9 A, B, Marked flexion contraction of index and middle fingers following burn in a 3 year old child C, D, Result after excision of contracting scar and application of a Wolfe graft to the defect

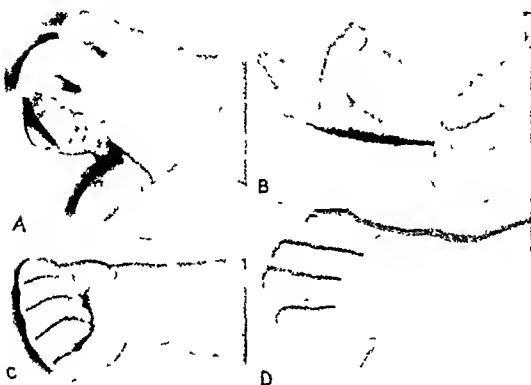


Fig 9

Fig 10 A, B, Finger flexion contractions of 11 years' duration in a 12 year old boy C and D, Result 1 year later following Wolfe grafting Traction was applied for several months

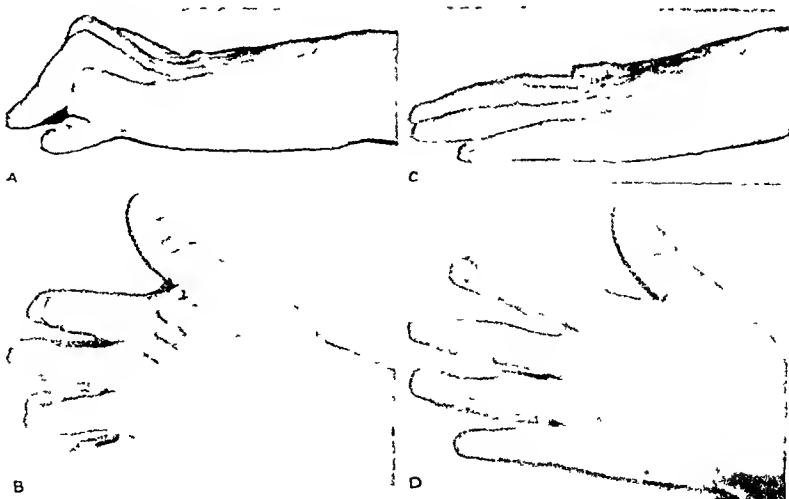


Fig 10.





Fig 11



Fig 12



Fig 14

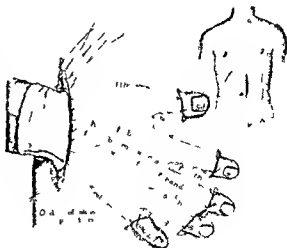


Fig 1

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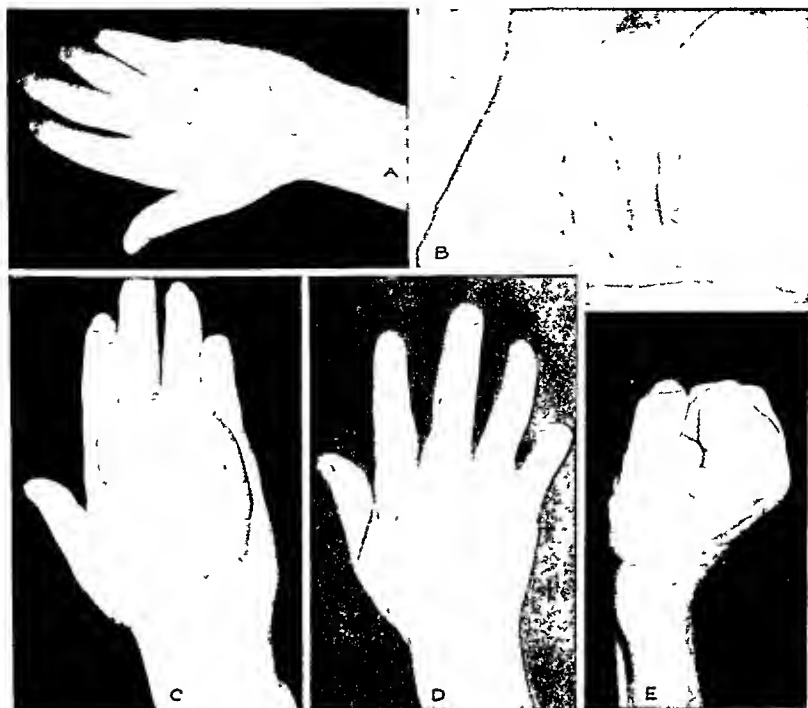


Fig 13

areas of skin from the hand, Blair's graft is of considerable value. In marked contractures of the dorsal surface of the hand, for which gradual traction may be necessary, this graft is useful as a preliminary step and may even obviate the use of pedicle flaps. This graft should be used only temporarily on the volar aspect of the hand or fingers, as it does not stand trauma well in this region.

The free full thickness skin graft is functionally and cosmetically better than the split graft. It

should be used, however, only on freshly excised or avulsed surfaces, as it will not take in the

Cotton glove on hand ready for placement of skin graft

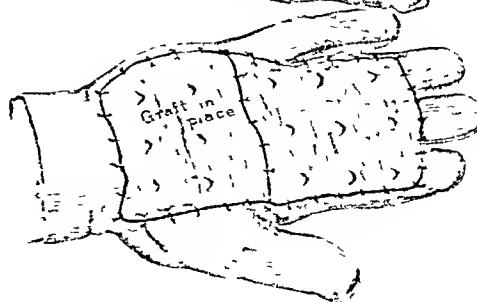
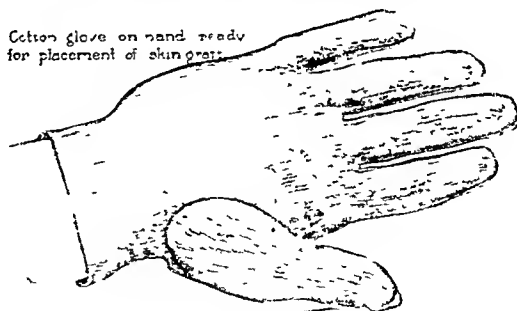


Fig 16

Fig 11 A and B, Flexion contraction following burn. Thiersch grafts had been used as primary covering. C, Abdominal pedicle attached to hand at the time of severance. D, Final result.

Fig 12 A and B, Marked hyperextension contraction following burns from gasoline explosion. C and D, Result after three split grafting operations and traction.

Fig 13 A, Healed dorsal contraction. B, Hand under small glove flap. C, Fingers syndactylized. D and E, After thinning flap and making webs.

Fig 14 A and B, Marked diffuse scarring of dorsum of hand preventing flexion. Ideal case for glove type flap.

Fig 15 Position of abdominal pocket and the order in which the pedicles were resected.

Fig 16 Demonstrates cotton glove on volar aspect of hand to which two split grafts had been sewed, raw side out. When the hand was placed in the abdominal pocket these grafts covered the base of the pocket.

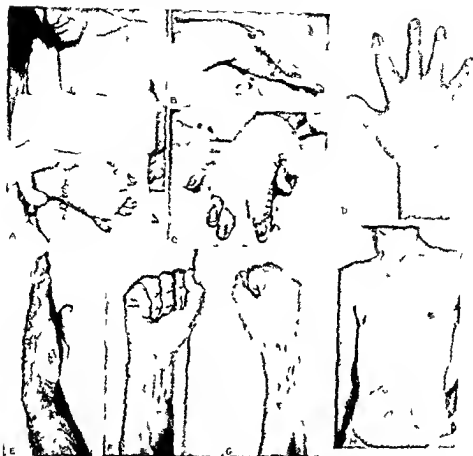


Fig 17 A Hand under glove pedicle. Ulnar pedicle has been cut. B After cutting and suturing ulnar pedicle. C After cutting and suturing portions of thumb and index finger pedicles. D E F and G After completion of case. H Appearance of abdomen.

presence of infection. It is highly recommended for all small losses of skin, particularly on the fingers. Inexperienced surgeons should use this graft cautiously as their success will be limited.

For the covering of most large areas, particularly if deeper structures such as muscles, tendons, nerves or joints are involved, dermosubcutaneous pedicle flaps should be used. This type of graft properly fashioned, produces the best functional and cosmetic result. Inasmuch as two or more operative steps are always required for its construction and application the additional surgery must be justified.

#### OPERATIVE TECHNIQUE

**Split grafts (Blair Brown technique)** The surface of the donor skin is coated with a thin layer of white vaseline. By means of the Blair suction boxes and knife, a graft of the desired size and

thickness is cut, immediately placed on the denuded area, and sewed into place by a continuous horsehair suture. The suture approximates the overlapping edge of the graft to the cut edge of the defect and the central portion of the graft to the underlying granulating area (Fig. 1). V shaped incisions are made in the graft for drainage. A pressure dressing is applied consisting of layers of scarlet red oxyquinoline gauze, moist gauze and moist sea sponges held in place by adhesive tape. If this type of graft is used on a granulating area of questionable cleanliness, Dakin tubes are included in the dressing thus permitting the intermittent injection of warm saline solution to keep the dressings warm and moist (Fig. 2). The dressing is changed in from 3 to 7 days, depending on the patient's course and the amount of secretion

which occurs. The pressure dressing is changed as necessary and maintained from 7 to 10 days, varying with the completeness of the take.

**Wolfe grafts** One must remember that these grafts are hair-bearing and the donor site must be carefully chosen. A pattern of the defect is made of thin lead plate. The pattern is placed against the donor skin, and its outline is traced. By means of small skin hooks and a small knife, the full thickness of the skin is dissected from the underlying subcutaneous tissue. No subcutaneous tissue should be left on the graft. The graft is fitted accurately to the defect and is sutured into place by interrupted fine silk sutures which are left long. A continuous suture of horse-hair is also used to approximate the edges of the graft to the skin. "V" shaped incisions are made in the graft for drainage (Fig. 3, A). A pressure dressing of scarlet red gauze and moist gauze is tied in place by the long silk sutures (Fig. 3, B and C). Further pressure is added by means of additional gauze and moist sea sponges (Fig. 4, A, B, C and Fig. 5, A and B). This dressing is not changed for 10 days. At that time the sutures are removed and pressure dressings, compresses, or grease gauze are applied as indicated.

**Pedicle flaps** The abdomen, if unscarred, is usually chosen as the donor area. Two parallel incisions are made with the desired width of skin between them, conforming with Sanger's lines if possible. This flap of skin and subcutaneous tissue between the two parallel lines is raised from its bed, replaced, and resutured. The base beneath the flap may be grafted at the time, if later closure is impossible. After 2 weeks, the distal extremity of the flap is resected, replaced, and sutured. A few days later after its viability has been demonstrated, the flap is raised again and approximated to the defect by interrupted catgut sutures subcutaneously and silk sutures in the skin. The skin sutures are left long, and are tied over a pressure dressing to eliminate dead space and prevent venous stasis and edema (Fig. 6, A and B). This pressure is not disturbed for from 10 to 14 days, when the sutures are removed, the pedicle is resected, and the proximal portion of the pedicle replaced.

For the replacement of large areas on the dorsum of the hand, the gauntlet or glove flap is used. The abdomen is always used as the donor site unless this is contra-indicated. If only the dorsum of the hand is involved, a bi-pedicle

flap may be used. If the fingers are also involved, they may be syndactylized under the skin flap and later separated, or smaller pedicles may be fashioned initially as a part of the main flap. If multiple small narrow pedicles are used, only one side should be cut at a time or the circulation may not be sufficient to keep the small flap alive. An interval of from 5 to 7 days is usually sufficient. Tubed pedicles may be used for reconstruction of the hand, but this graft is usually too bulky after its application, requiring additional steps for thinning.

The rules governing our use of these grafts in burns and contractures of the hand may be tabulated as follows:

#### EARLY CASES

(unepithelialized)

##### *Split graft*

for cases in which deep structures are not involved (Fig. 7, A and B)

##### *Dermosubcutaneous flap*

for cases in which deep structures are involved (Fig. 8, A to E)

#### LATE CASES

##### *Volar Surface Contractures*

##### *Wolfe graft*

for fingers, webs, and distal portion of palm (Fig. 9, A to D and Fig. 10, A, B, C, D)

##### *Split graft*

for webs

##### *Dermosubcutaneous graft*

pedicle flap for palm (Fig. 11, A to D)

##### *Dorsal Surface Contractures*

##### *Wolfe graft*

for small areas and fingers

##### *Split graft*

for hyperextension (Fig. 12, A to D)

##### *Glove pedicle graft*

(Fig. 13, A to E and Figs. 14, 15, 16, and 17)

#### CONCLUSIONS

1 Burn contractures of the hand may frequently be prevented by early and proper skin grafting.

2 A detailed examination of the altered anatomy and a careful evaluation of its function must be carried out before a plan of reconstruction is decided upon.

3 The standard types of skin grafts used for hand surface reconstruction are enumerated.

4 The technique essential for the successful use of these grafts is briefly described.

5 Principles governing our use of these grafts in burns of the hand and contractures due to burns are presented.



Fig. 17. A Hand under glove pedicle. Ulnar pedicle has been cut. B After cutting and suturing ulnar pedicle. C After cutting and suturing portions of thumb and index finger pedicles. D, E, F and G After completion of case. H Appearance of abdomen.

presence of infection. It is highly recommended for all small losses of skin, particularly on the fingers. Inexperienced surgeons should use this graft cautiously as their success will be limited.

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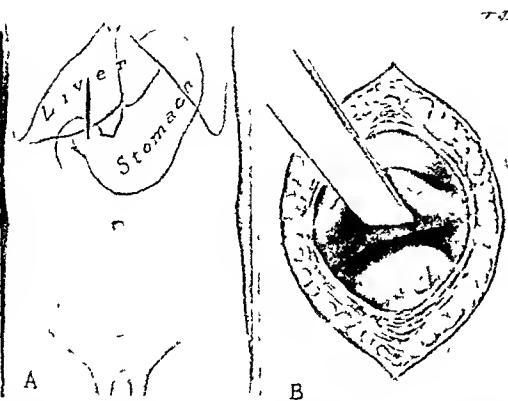


Fig 3 A, Correct location of incision in hypertrophic pyloric stenosis B, Exposure of the pyloric area by elevation of the right lobe of the liver

important diagnostic point, and in all cases demonstration of the presence of a tumor is a source of satisfaction

Prior to operation the stomach should be emptied by means of a soft rubber catheter. If gastric lavage is done before operation, it is well to allow the catheter to remain in the stomach until the operation is completed. The tendency of these patients to suffer disruption of the wound has been commented on by several writers, but the importance of this tendency cannot be over-emphasized. The operative procedure entailed in the Ramstedt type of operation does not necessitate a large incision. An incision 3 centimeters in length is sufficient. This should be located in the

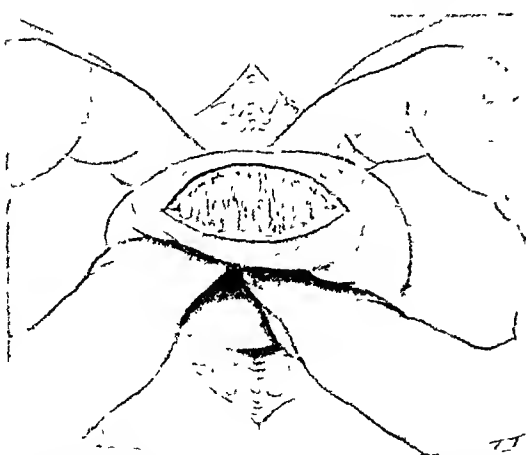


Fig 5 Examination of entire pyloric area after completion of operation to insure complete division of fibers, and to detect possible injury to duodenal mucosa

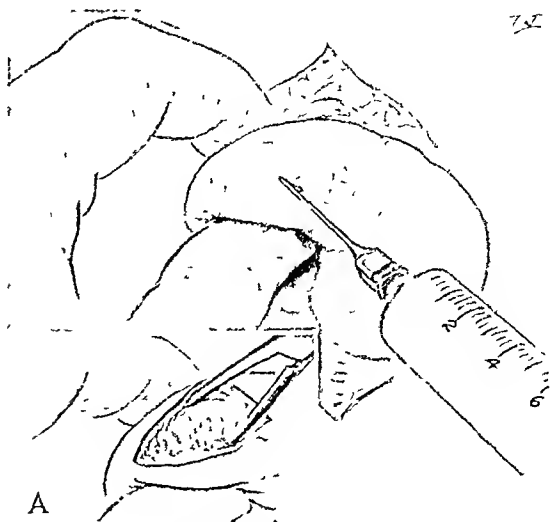


Fig 4 Injection of the tumor with normal saline solution to facilitate dissection A, Separation of tumor from mucous layer by stretching with forceps after superficial incision into tumor

upper right quadrant of the abdomen with at least the upper 2 centimeters above the lower margin of the liver. The incision should be approximately 2 centimeters from the midline. When the incision is made at this point, the liver will protect the abdominal wall during the post-operative stage of healing. Exposure of the

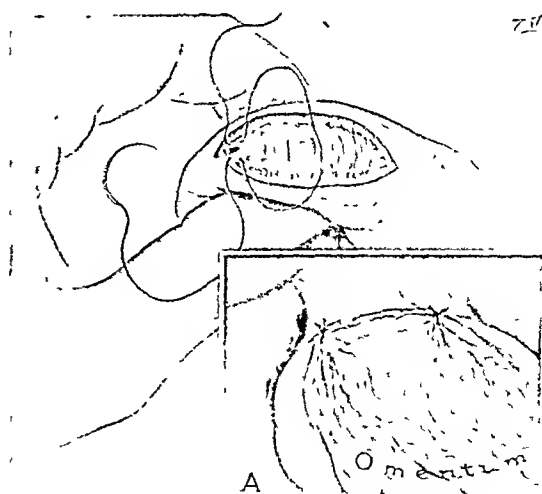


Fig 6 Closure of perforation into duodenum by mattress suture A, Omentum sutured in position over pyloric area

# TECHNICAL NOTES ON HYPERTROPHIC PYLORIC STENOSIS

STANLEY J. SIEGGER, M.D., F.A.C.S. Milwaukee, Wisconsin

THE Ramstedt operation has been generally accepted as the operative procedure of choice in hypertrophic pyloric stenosis. The apparent simplicity of this procedure is one of its principal dangers. An exact knowledge of the anatomical arrangement of the pyloric ring and the duodenal mucosa is necessary to avoid the accident of opening the duodenum. A small wound through the duodenal mucosa is easily overlooked unless one is aware of the danger of this accident and makes examination for its presence a routine step in the operative management. In dividing the tumor and separating it from the mucous layer great care must be exercised not to overlook obstructing fibers.

The symptoms and sign of hypertrophic pyloric stenosis need not be recounted here. Palpation of the tumor is a diagnostic sign of importance concerning which a difference of practice exists in various clinics. Some clinicians are reluctant to refer patients for operation unless the tumor can be palpated. Others search for the tumor rather casually, and failure to palpate it is not considered of great importance. Unless palpation for the tumor is done in a methodical manner it will be felt in only a small percentage of cases but when one is willing to exercise patience it can

From the Milwaukee Children's Hospital

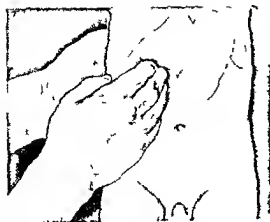


Fig. 1. Palpation of the tumor. The tumor can be felt in most instances when the technical details of palpation are carefully observed.

usually be felt. When palpation for the tumor is practised the infant should be placed on a table and the operator seated to the patient's right with the left hand on the right lumbar area and with the right hand on the anterior wall of the abdomen. The table and chair should be of such a height as to allow the operator's arms to rest in a comfortable position. The hands of the operator should be warm. Under these circumstances, bimanual palpation over the pyloric area will usually enable one to feel the tumor. Should the child be tense and the abdomen be held rigid because of crying a bottle of warm water should be offered. After this has been taken palpation should be resumed. The child usually vomits quite promptly and during the temporary relaxation following the throwing up of the food frequently one is able to feel the tumor. If vomiting does not occur the stomach should be emptied by a soft rubber catheter. Relaxation may also be obtained by immersion of the infant in a warm bath.

While palpation of the tumor is not essential to the diagnosis it is in some cases a very

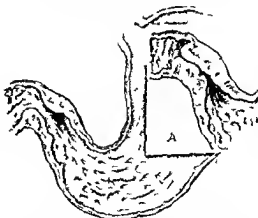


Fig. 2. Schematic representation of the arrangement of the gastric pyloric and duodenal mucosa illustrating the angulation of the duodenal mucosa by the pyloric ring. A. Cross section of pyloric area in cases of hypertrophic pyloric stenosis illustrating the exaggeration of the angle in the duodenal mucosa produced by the tumor. This drawing illustrates the danger of perforation of the duodenal mucosa to the performance of the Ramstedt operation.

that which is secured under ether anesthesia and in several instances, during the process of operation we have noted untoward symptoms such as mild convulsive seizures, which we have attributed to the novocain solution. In no instances have these symptoms been followed by serious complications.

## REFERENCES

- 1 DOWNES, WILLIAM A, and BOLLING, R W Congenital Hypertrophic Stenosis In Lewis' Practice of Surgery Chap 7, pp 1-28 Hagerstown, Md W F Prior Co, Inc, 1929
- 2 LEWIS, DEAN Congenital pyloric stenosis Surg Clin, Chicago, 1917, 1 125-133
- 3 MONTGOMERY, A H Personal communications

## EXTRAPERITONEAL IMPLANTATION OF THE COLON

## One-Stage Resection for Carcinoma

WILLIAM T HARSHA, M D, F A.C.S., and WILLIAM T HARSHA, Jr., M D,  
Chicago, Illinois

**I**N cancer of the colon a method of extraperitoneal resection is employed in a one-stage operation, which permits adequate excision and avoids both peritonitis and fistula. Because of the production of fecal fistulas two or more stage operations are repugnant both to the patient and the physician (1, 2). This technique is applicable only to certain selected cases of carcinoma of the cecum, ascending and descending colon, and sigmoid. Individual variations in the technique, necessitated by the position of the tumor, may suggest themselves to the surgically qualified reader, and possibly he may desire to extend its limitations.

The advent of modern roentgenological technique and the wider dissemination of popular knowledge concerning cancer have aided in earlier diagnosis, and it is only through early diagnosis that such an approach as is herein described can be used.

An accurate localizing diagnosis must be made before the onset of total obstruction, otherwise preliminary colostomy or enterostomy is necessary. The patient is put upon a liquid diet for 5 or 6 days. The intestinal tract is thoroughly cleaned out and decompressed by mild catharsis prior to operation.

The steps in the operation are shown in the illustrations.

An incision is made from the costal margin on the left side, following the lateral margin of the left rectus muscle, downward to about 2 inches above Poupart's ligament (Fig. 1, A). The external oblique aponeurosis is incised and the aponeurosis is split longitudinally just lateral to the

lateral border of the rectus. This incision of the external oblique aponeurosis is carried downward to a point just above the external inguinal ring. This division of the external oblique aponeurosis is done with scissors and follows the lateral margin of the rectus in the whole length of the skin incision (Fig. 1, B).

The internal oblique and transversalis muscles are split transversely in the direction of their fibers, as in the McBurney incision, at a point opposite to the anterior superior spine of the ilium. This is to afford access to the retroperitoneal line of cleavage between peritoneum and musculature of the abdominal wall. Then the abdominal wall is carefully separated from the peritoneum with the hand, working upward and

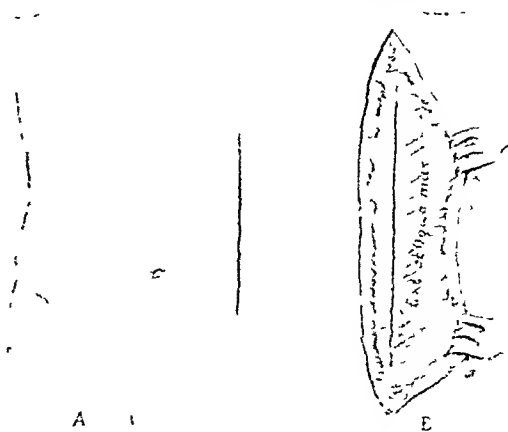


Fig 1 A, Line of incision, B, division of external oblique aponeurosis





Fig. 7. Photograph of mucous surface of stomach pyloric area and duodenum in a case of hypertrophic pyloric stenosis illustrating the reduplication of the duodenal mucosa and its proximity to the peritoneal surface at the caudal end of the tumor.

pylorus is easily effected by the gentle elevation of the lower margin of the right lobe of the liver by means of a small straight blade retractor.

When the stomach is identified, a small portion on the anterior wall should first be brought into the wound and then drawn to the patient's right. When the stomach is then brought over to the left, the pylorus comes easily into view. The tumor as well as the adjacent duodenum is held in the left hand between the thumb and the index finger.

In patients who have a marked degree of obstruction, the tumor is frequently somewhat edematous. Such tumors are easier to separate from the mucosa and bleed less than do those in which there is no edema. Acting on this observation we have injected from one to  $1\frac{1}{2}$  cubic centimeters of water or normal saline solution into the tumor in most cases, and have found that this facilitates the ease with which separation of the muscularis from the mucosa can be accomplished. Bleeding from the cut edge should always be observed, and if it is found that any points bleed actively they should be controlled by means of ligation.

A thorough knowledge of the anatomical arrangement of the duodenal mucosa at its junction with the pylorus is of great importance when one is performing the Ramstedt operation. The arrangement has been commented on by several writers and is illustrated in standard anatomical textbooks but has not been sufficiently emphasized (1). The pyloric ring produces a sharp constriction of the mucosa of the stomach and duo-

denum. There is practically no danger of puncturing the gastric mucosa as one separates the mucosa from the mucous membrane upward on the gastric side. The duodenal mucosa which has been constricted by the pyloric ring, approaches the wall of the duodenum at a right angle or at an acute angle which points toward the stomach. For this reason, in approaching the duodenum in the separation of the tumor from the mucosa, one must exert extreme care not to puncture the membrane, the angle of which is quite superficial at this point. The pyloric tumor not infrequently has pushed into the duodenum so that its anatomical relation to the bowel is quite similar to that of the cervix to the wall of the vagina.

On completing dissection of the tumor and separation from the mucous membrane by spreading with a forceps one should carefully examine the area for possible puncture of the duodenum. This is best done by holding the duodenum and the tumor between the thumb and index finger of the left hand and by holding the stomach just above the tumor between the thumb and index finger of the right hand. By gently approximating the two hands one can exert sufficient pressure to demonstrate any damage to the mucosa.

Puncture of the duodenum however is not a serious complication if one notes that it has occurred and repairs the damage properly. The accident is easily overlooked and we have seen instances in which this has occurred. The puncture wound may be small but it can be identified by the everted mucous membrane and usually a small bubble of bile stained fluid can be expressed. Montgomery has suggested that the area suspected of puncture be moistened with normal saline solution. Pressure upon the duodenum if it is punctured will produce small bubbles which enable one to identify a very small opening. When the duodenum is perforated the defect should be closed by one or at the most two simple mattress sutures of No. 6 chromic catgut. By using a Connell type of suture the margin can be inverted. The area should then be covered with the omentum which is fixed in place with several stitches.

We prefer ether anesthesia by the open drop method in these cases. The operation does not consume much time and a small amount of ether affords complete relaxation. We have never regretted its use. The operation can be performed by local infiltration anesthesia and this method is preferred by some surgeons. The relaxation afforded by this method is not as satisfactory as

that which is secured under ether anesthesia and in several instances, during the process of operation we have noted untoward symptoms such as mild convulsive seizures, which we have attributed to the novocain solution. In no instances have these symptoms been followed by serious complications.

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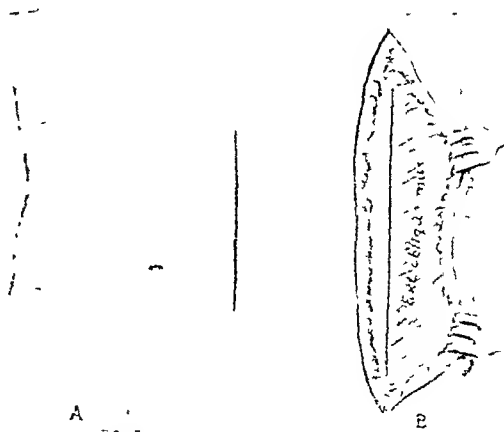


Fig 1. A, Line of incision, B, division of external oblique aponeurosis

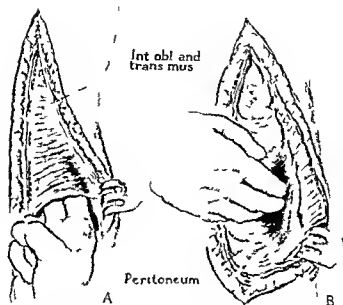


Fig 2 A Separation of abdominal wall from peritoneum B peritoneum exposed

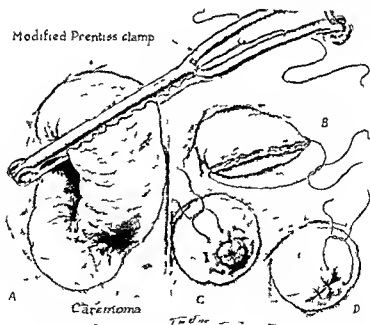


Fig 3 A Colon withdrawn through peritoneal incision and tumor located Prentiss clamp applied B C and D further steps in removal of tumor and closure of stumps



Fig 4 A and B, Steps in lateral anastomosis, C, complete isolation of the extruded anastomosis from peritoneal cavity

downward from this split in the internal oblique and transversalis muscles. Then with scissors the transversalis and internal oblique are cut again, paralleling the rectus margin. This longitudinal division of the internal oblique and transversalis is also carried parallel to the skin incision, equaling the skin incision in length, and parallel to the division of the external oblique aponeurosis. This exposes unopened peritoneum. The peritoneum must be carefully protected against injury, particularly in the upper part of the incision. It is more firmly attached above the level of the umbilicus than it is below it (Fig 2, A and B).

With this large incision and complete separation of the fascia and muscles of the abdominal wall access is obtained to the retroperitoneal space behind the colon, and in relation above to the kidney and below to the retroperitoneal tissue, fat, areolar tissue, and muscles of the true and false pelvis. Extraperitoneal separation of the colon from the posterior parietal wall is done by blunt dissection with the fingers and with gauze. This exposure of the peritoneum laterally permits palpation of the bowel and determination of the tumor mass, its site and extent, prior to incision of the peritoneum.

When carefully done, the separation of the colon posteriorly is easy and bloodless. When extended toward the midline the ureter should be identified.

The tumor mass to be resected is identified through the peritoneum by palpation and the site of its extrusion is chosen. An incision into the peritoneum, about 2 inches in length, is made lateral and anterior to the position of the tumor, and the portion of the colon to be resected is

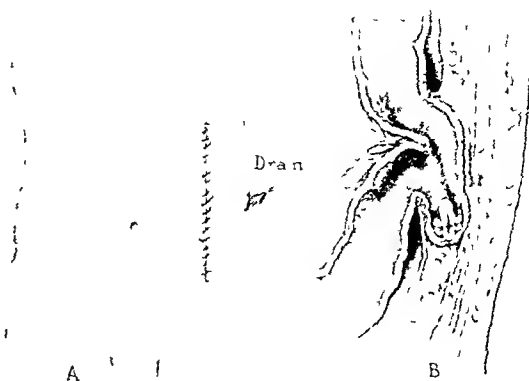


Fig 5 A, The abdomen is firmly closed in layers and stab wound in side for drain, B, sectional view. Care is taken to prevent leakage.

withdrawn through the peritoneal incision and isolated. With proper mobilization and free extraperitoneal dissection the descending colon is accessible in most of its length. The field is properly protected with gauze. Examination is made for local lymph glands and the extent of the tumor mass is further ascertained. The site of resection is then chosen (Fig 3, A).

The tumor mass as drawn through the peritoneal incision is excised between Prentiss clamps with the electrocautery. A needle threaded with



Fig 6 Photograph of specimen removed



Fig 7 Roentgenogram before operation

double linen is passed through the Prentiss clamp and tied. A purse string invaginates the tied ends and this pursestring is buried by additional sutures further invaginating and protecting the stump from opening. Both ends are carefully sealed and then approximated to each other (Fig 3, B, C and D).

At a distance of about 15 inches from the blind and sealed stumps a lateral anastomosis, colon to colon is done with two layers of linen (Fig 4, B).

The peritoneum is now sutured to the bowel proximal to the area with interrupted linen sutures closely approximating peritoneum to bowel serosa and completely isolating the extruded anastomosis from the peritoneal cavity about 1 inch proximal from the side-to-side anastomosis (Fig 4, C).

A large free stab wound is made in the flank just above the iliac crest, and a fenestrated rubber tube drain placed below the blind stumps. The abdomen is firmly closed in layers (Fig 5 A).

The blind ends are sutured together (8) in the hope of better maintaining the physiological integrity of the bowel, with consideration to the peripheral nervous mechanisms within it, as well as its support from the abdominal wall and to further prevent leakage (Fig 5 B).

The extrusion of a blind stump was first suggested and called the thumb method by Blood



Fig 8 Roentgenogram after operation

good (9) and used successfully by him. His approach was an intraperitoneal one and the anastomosis was left intraperitoneally.

The side-to-side anastomosis was used because of previous failures in attempts at end-to-end anastomosis. While fistulas have developed in end-to-end anastomoses by this extraperitoneal method they have remained extraperitoneal and without systemic repercussion.

Considering the mobility of the colon from an embryological and anatomical point of view (10) and the distribution of its blood supply from central sources in a manner permitting considerable elasticity, it would seem that an operation requiring considerable mobilization is morphologically sound.

The extraperitoneal approach is an old one antedating the days of antiseptic surgery by its use in the older cesarean sections and in the pre-antiseptic methods of approach to carcinoma of the large bowel. The later uses of the extraperitoneal approach have been mostly in modern cesarean section and in work on the kidney and ureter such as done by Hugh Cabot.

The approach seems a logical one in properly located and selected tumors of the bowel. Properly speaking it is not entirely extraperitoneal as the peritoneum is opened for the delivery of the tumor. Practically by exclusion of the operative field from the peritoneal cavity the operation can in this sense only be called extraperitoneal. It is

seen that none of the features of this technique are new, yet the combination of them has resulted in a satisfactory approach. This extraperitoneal position of the anastomosis is of great advantage in avoiding peritoneal infection.

The two-stage operation suggested by Heinecke and published by Oscar Bloch in 1892 was popularized by Mikulicz and has superseded the one-stage operation as a measure of safety in certain cases of carcinoma of the colon. Adopted by Bruns and Mayo (9) it is now called the Mikulicz-Bruns-Mayo operation. The production of slow closing fistula adds to the difficulty of the operation. One-stage intra-abdominal operations by lateral anastomosis are often chosen in preference to the Mikulicz procedure. In no other circumstance is surgical judgment as to the type of operation more difficult (3). It is to be hoped that the

method may be an addition to those at our disposal.

#### BIBLIOGRAPHY

- 1 ANSCHUTZ, WILLIE. Quoted by Rovsing. *Centralblatt f. Chir.*, 1892, p. 628.
- 2 Idem. *Mitt. u. d. Grenzgeb. d. Med. u. Chir. Supplementband. Gedenkb. fuer J. von Mikulicz*, 1907, p. 564.
- 3 BLOODGOOD, JOSEPH C. *Tr. Am. Surg. Ass.*, 27, 340.
- 4 Idem. *Ann. Surg.*, 1909, Feb., 362.
- 5 CABOT, HUGH. The methods of diverting urine above the level of the bladder with particular reference to problems of technique. *J. Urol.*, 1936, 35, 596-609.
- 6 GOULLIQUET, P., and FAYSSIE. De l'amputation abdomino-perineale du rectum cancéreux. *Rev. de Chir.*, 1905, 25, 711-735.
- 7 KIEBEL and MALL. Section on Development of Large Intestine. Vol. 2, pp. 393-399. Philadelphia: J. B. Lippincott Co., 1912.
- 8 KIRTH, ARTHUR. *Brit. J. Surg.*, 1914-1915, 576.
- 9 MAYO, W. J. *Tr. Am. Surg. Ass.*, vol. 30, p. 158.

## A WAI KING IRON FOR IMMEDIATE USE ON WET PLASTER CASTS

BERNARD B LARSEN, M D, F A C S, Cleveland Ohio

THE use of walking irons on fractures of the lower extremities is advocated because of increased comfort and decrease in economic loss to the patient and because of the prevention to a great extent of muscle atrophy which in turn means a decrease in the time necessary for the return of maximum function. This therapy is best suited to fractures of the ankle in which the weight bearing is not greatly interfered with, such as fractures of one or both malleoli or fracture dislocations with the posterior portion of the tibia broken off. This method may also be applied in some fractures of the foot, and in fractures of the long bones or of the os lakus if Steinmann pins or Hirschner wires are properly incorporated in the plaster so as to bear the weight. Many men who are convinced of the benefits of walking on a fractured extremity when the nature of the fracture permits do not generally use walking irons because of the technical difficulties involved. In the hope that this type of therapy will be better applied and further popularized this article introduces a modification of the old type walking iron which overcomes some of the technical difficulties of application as well as provides greater safety to the patient.

To my knowledge all walking irons whether the loop crutch tip, or skate type are now made of the same weight material throughout. Any such walking iron of sufficiently heavy material to carry the patient's weight is of necessity difficult to bend and therefore the accurate fitting of such an iron to a cast requires previous skill and labor especially if proper bending irons are not available. The iron must not be applied until after the cast is well hardened so that pressure caused on the cast by the necessarily imperfect fit of the iron will not be transmitted through onto the extremity. The failure to observe this rule and the failure to use unpadding plaster are the principal causes for a great deal of pain and not a few of the pressure sores produced by the use of walking irons.

To minimize these difficulties, we have devised a walking iron with flexible upright portions.

From the Department of Surgery, School of Medicine, Western Reserve University and the Cleveland City Hospital.

which we have used with universal success the past 18 months (Fig 1). The flexible uprights fit themselves to the curves of the plaster when applied and though they are thin and very flexible being made of spring brass they are able to bear weight because they are held tightly between the layers of the plaster cast and perforations made with a nail from the inside out through these uprights keep them from slipping. The stirrup portion is of rigid duraluminum and wide enough so that it does not impinge on the plaster over the malleoli. On the stirrup is a metal peg covered with a crutch tip which rotates in a simple swivel joint facilitating rotation without much friction. This makes walking easier and the rubber crutch tip wears much longer than if the peg is fixed. We believe patients are less apt to slip or trip on a swivel type crutch tip than on a loop or skate type of iron. The construction of this walking iron is simple and inexpensive. It does not rust and may be used time and time again.

This iron is applied according to the method of Boehler<sup>2</sup> after local anesthesia is applied at the site of fracture. If the edema is not marked it is massaged away so as to allow accurate molding of the plaster. If edema is marked some other form of immobilization is used until the edema subsides. It must be borne in mind that the quickest and easiest way to get rid of swelling is to reduce the fracture. This is usually done with the patient sitting on a table with the injured extremity being supported by the operator's knee (Fig. 3) and the foot held in the optimum position. The patient's other foot is placed on a stool for balance. A piece of stockinette about 6 inches wide is slipped on and placed just below the knee and over the lower portion of this fastened with adhesive is placed a 2 inch strip of thin felt (Fig. 2). A very wet plaster strip 4 to 6 inches wide about six layers thick and of a previously measured length is then placed in stirrup fashion around the foot and leg directly on the unshaven skin (Figs. 3 and 4) and held in place by a single layer of gauze bandage so that the operator may mold the plaster about the bone.

The operator may direct the purchaser from the Rice Ship at G. A.  
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 W. near Indiana.  
 No. 10. L. n. T. T. T. n. t. of F. T. e. 4th A. D. 10-43.  
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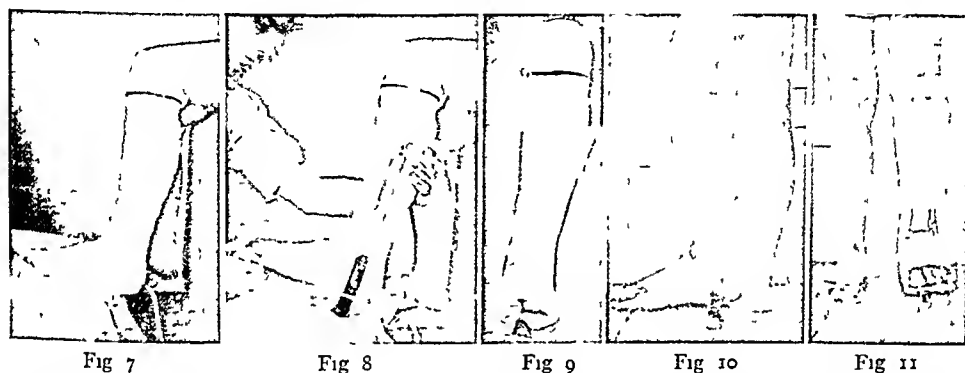
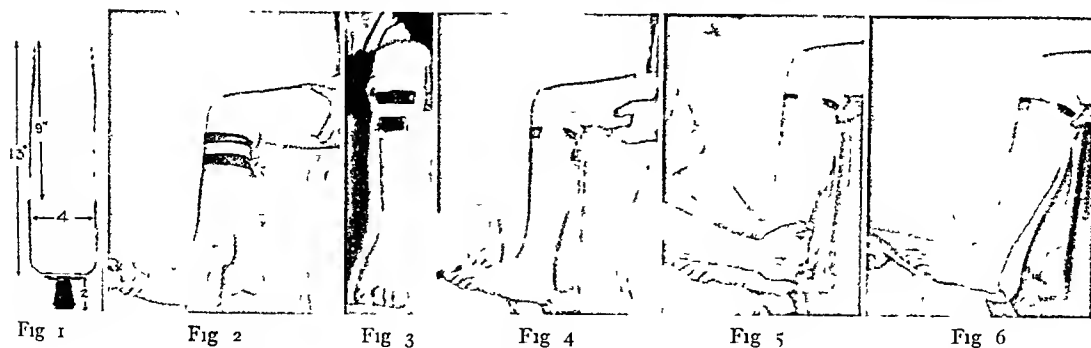


Fig 1 Walking iron with flexible uprights, rigid stirrup, and swivel crutch tip

Fig 2 Position of patient and operator for application of unpadded plaster leg cast Local anesthesia Stockinette and felt in place

Fig 3 Anterior view of stirrup plaster placed directly on skin

Fig 4 Lateral view of stirrup plaster applied directly on the skin

Fig 5 Stirrup plaster held in position by gauze bandage The plaster is being molded about the ankle

Fig 6 Posterior splint Note notching at the heel

Fig 7 Circular plaster applied over splints

Fig 8 Walking iron in long axis of leg applied on wet cast

Fig 9 Anterior view of iron in position Note space between the rigid portion of iron and plaster over malleoli

Figs 10 and 11 The cast completed and iron in position

prominences with the flat of the hands without creases or wrinkles (Fig 5) After this stirrup splint has set well enough to hold its shape, the supporting gauze bandage may or may not be cut and removed and a posterior splint of wet plaster 4 to 6 inches wide and about six layers thick is applied, the strip being notched at the bend in the heel so as to lie smoothly (Fig 6) It is absolutely essential that these strips be applied while wet and soft If they are not absolutely soft, uneven pressure with its sometimes disastrous results will follow The circular plaster bandage is now applied, care being taken that it is absolutely smooth over the anterior portion, making any reverses or turns over the previously applied splints (Fig 7) This plaster is quite tightly applied, especially over the upper portion of the cast

Without delay the walking iron is put into position exactly in the weight bearing line (Fig 8)

It will be noted in the anterior view (Fig 9) that the heavy duraluminum portion of the splint is wide enough to avoid pressure on the malleoli If the extremity is supported as shown in Figures 8 and 9, care must be taken that the patient does not put much weight on the stirrup, it is usually best to continue supporting the foot as was done when the splints were applied The stockinette at the upper edge of the cast is now turned down so as to make this edge smooth With the walking iron held in position, one or two plaster bandages are now applied over it, thus molding the flexible uprights to fit the contours of the cast without uneven distribution of pressure (Figs 10 and 11) Care must be taken to cover also the rigid portion of the uprights The cast is trimmed exactly at the base of the toes so that the toes may be moved freely, care must be taken not to trim the cast proximal to the base of the toes or



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<sup>1</sup> This walking iron is purchased from the Bryant Iron & Co. 1100 5th Ave. N. W. Minneapolis, Minn. 55403. It is the D.P. Co. design. I, Bernard B. Larsen, The Tre. of Fract. 2nd ed. pp. 430-434. Translated by Ernest W. Tracy, M.D. 1945.

# SURGICAL ASPECTS OF NEUROGENIC TUMORS OF THE ABDOMEN

V L SCHRAGER, M D , F A C S , Chicago, Illinois

NEUROGENIC tumors of the abdomen encountered in general surgery have seldom been diagnosed accurately before exploration. These neoplasms have no pathognomonic characteristics by which they may be readily recognized. The conjectural diagnostic aspects are not settled even by exploration, as the surgeon usually bases his opinion upon his impression of the gross appearance of the tumor and upon resemblance with other neoplasms with which he is familiar. Competent histopathological reports disclose the identity and nature of the tumor, which usually intrigue the surgeon heretofore unfamiliar with these rare neoplasms.

The present study is based upon clinical and surgical experiences with two types of neurogenic tumors (a) schwannoblastoma (neurinoma) and (b) retroperitoneal sympatheticoblastoma (neurocytoma).

## SCHWANNOLASTOMA (NEURINOMA)

José Verocay was the first to describe these tumors and differentiate them from neuromas on histological grounds. He coined the term "neurinoma" in 1910. Verocay and Antoni were of the opinion that these tumors originated from the sheath of Schwann, or from the cellular ancestors of the sheath, designated by them as lemmoblasts.

The terminology of this type of tumor is varied and may be explained as follows: (a) gross diagnosis without histological verification, or inaccurate histological interpretation, (b) divergence of opinion among histopathologists and personal preference of terminology.

This accounts for such terms as schwannoblastoma, neurinoma, solitary neurofibroma, perineural fibroblastoma, peripheral glioma, sarcoma, fibrosarcoma, fibromyxosarcoma, malignant leiomyoma. A more definite study of these neoplasms will tend to reduce the terminology to that most frequently used in medical literature, i.e., neurinoma and schwannoma, or schwannoblastoma.

Arthur Purdy Stout objects to the term neurinoma because it suggests nerve fiber tumor, when in reality the tumor originates from the sheath of Schwann. F. H. Vizetelly, editor of the *New Standard Dictionary*, prefers neurilenoma instead of neurinoma.

The scarcity of these neoplasms may be inferred by the absence of mention in collective reviews of benign neoplasms of the stomach. Balfour and Henderson, who reported 58 cases of benign tumors of the stomach from the Mayo Clinic, do not speak of schwannoma. Likewise, Elason and Wright in a discussion of benign tumors of the stomach failed to mention this type of tumor.

Schwannoblastoma usually develops from the stomach wall, although it has been encountered in other tissues, such as appendix, extremities, upper respiratory organs, tongue, eye, and orbit. Schwannoma in the first portion of the duodenum was described by Lemonnier and Peycelon. Peretz reported a case of neurinoma of the appendix. Dyggve Petersen reported 20 cases of intrathoracic neurinomas, all occurring in women and shown by x-rays to be in the paravertebral area.

Etiologically, there is no definite accounting for the origin of these tumors. The factors which initiate these tumors and spur them on to growth are shared by the growth of tumors in general. However, some pertinent and highly suggestive observations have been made to the effect that nerve proliferation is frequently observed in inflamed gastric mucosa on the edge of an active or cicatrizing ulcer (Masson). Jentzer found small neurinomas in the callous portion surrounding small gastric ulcers. Okkels observed marked proliferation in the nerves of the gastric walls surrounding the ulcer margin, which he defines as neurinoma scar. Similar observations have been made by Askenazy in gastric ulcers, the wall of a previously inflamed appendix, or in chronic obliterative appendicitis. These proliferative processes may attain neoplastic proportions and, thus, may explain in some measure the neoplastic origin from a simple proliferative process.

Since most of these tumors originate in the myenteric plexus of Auerbach, it may not be amiss to review briefly the arrangement of the nerve plexuses of the stomach wall. There are in

painful swelling of the dorsum of the foot may occur. The plantar portion of the cast is left long to protect the toes.

This completes the cast but the patient should remain in bed with the leg elevated for 24 hours. After this period if no abnormality is noticed, it is safe to begin weight bearing if there are signs of poor circulation to the toes the patient should remain in bed with the leg elevated until circulation is adequate, or if severe the cast should be removed and reapplied when edema has subsided. If the cast and iron are properly applied on properly chosen cases in which the fracture can be accurately reduced there should never occur painful and dangerous pressure areas. If pressure pain does occur, however the cast must be removed. Walking is sometimes not comfortable for the first 2 days until the patient has become accustomed to the apparatus. This accommodation occurs rapidly, especially in children and young adults and all are grateful to have a walking cast instead of having to hobble about on crutches since most of them go about their business with surprisingly little limitation of activity.

The cast if applied as here described is comparatively light. This walking iron weighs 14 ounces and the average total weight of cast and iron is  $3\frac{1}{2}$  pounds when dry. Likewise with this type of apparatus the circumference of the leg is not greatly increased and therefore it is not cumbersome.

After having used various types of light padding we are completely satisfied that unpadded plaster properly applied is more comfortable and less dangerous to the patient when walking irons are to be used. Padding tends to wad up and wrinkle with consequent pressure areas and discomfort and the fragments are more apt to slip out of position. In unpadded plaster there is practically no friction within the cast.

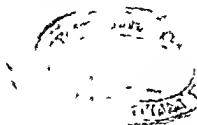
The removal of this skin tight plaster is not difficult. The hair on the leg changes about every 3 weeks so after this interval there is no pain on removal of the cast. Usually, if convenient, we have the patient soak the cast in water for an hour or two after which it is easily cut off. The cast is usually not removed until the fracture is quite well healed because the walking on the fractured extremity is physiotherapy in itself. Muscle atrophy is minimal. In many cases the patient puts on a shoe and walks immediately after the plaster is removed with surprisingly little discomfort or swelling.

#### STIRRUP

A new type of walking iron with flexible upright portions, a rigid stirrup, and a swivel type crutch tip is described.

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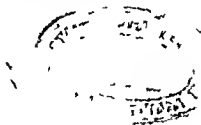
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#### ST. IMARY

A new type of walking iron, with flexible upright portions, a rigid stirrup and a snail type crutch tip is described.

This walking iron is immediately incorporated in a wet plaster cast without the danger of causing pressure areas.

The technique of applying an unpadded plaster boot with this walking iron is described.



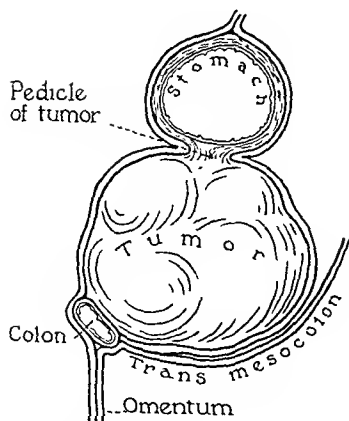


Fig 2 Sagittal section through stomach, tumor, and colon

all of the median epigastric masses or tumors, such as indurated pancreatitis, pancreatic cysts, also some of the more lateral masses, such as movable kidney, enlarged spleen, hydrops of the gall bladder, hydatid cysts of the liver, and retroperitoneal tumors

The indications for operation are the presence of a tumor mass, vague symptoms which do not come within the range of well defined gastro-intestinal clinical entities, with evidence of mechanical interference of function or the presence of hemorrhages

The removal of these tumors offers no difficulties. The tumor shells out well and the pedicle, often present, may be either ligated or sutured. If there is encroachment upon the lumen, a segment of the stomach may have to be removed and subsequently repaired.

#### SUMMARY HISTORY OF CASE OF SCHWANNOBlastoma

Mrs I G, age 46 years, was admitted to Cook County Hospital, Chicago, May 17, 1937, and discharged July 17, 1937.

For about one year patient complained of loss of appetite. She experienced a sense of fullness in the pelvis. She noticed an abdominal mass and an enlargement of the abdomen for about 1 year. She was free of gastro-intestinal symptoms except for occasional fullness after meals, no nausea or vomiting. She had a daily bowel movement. She had frequent urination but no pain. There was no loss of weight.

Examination revealed a slender woman in a state of fair general nutrition. Examination of the heart and lungs revealed nothing abnormal clinically. The abdomen was large and slightly tender to pressure, especially on the right side. There was an old operative scar in the middle line between the umbilicus and the symphysis pubis. A large

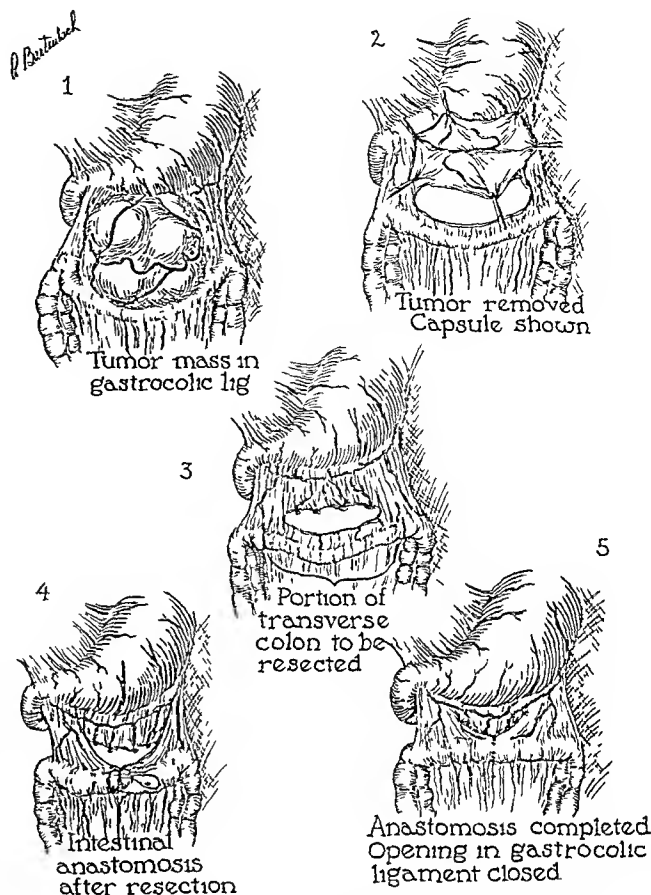


Fig 3 Relation of tumor to neighboring organs, before and after removal

mass, hard and fixed and filling the entire right half of the abdomen, could be readily palpated. There was a fluid wave present. Vaginal examination revealed a freely movable cervix, painless to movements. The fornices were free of masses or infiltration. Patient's menses ceased in 1933.

Patient had a gynecological laparotomy performed in 1934 at which time a 6 pound tumor had been removed. She states that at the time there was a great deal of fluid in the abdomen. She was never told what the nature of the tumor was.

X-ray investigation read as follows: moderate amount of opacity in the lower two-thirds of the abdomen. There is a scoliosis of the lower dorsal and upper lumbar spine. From the x-ray standpoint there was an extrinsic pelvic mass producing pressure defect on the pars pylorica of the stomach. There is also a rather constant irregularity of the lesser curvature of the stomach suggesting an intrinsic gastric lesion.

The clinical impression of the interne who wrote the history was ovarian tumor—probably Krukenberg tumor, ovarian cyst, gastro-intestinal malignancy.

**Surgical exploration.** A large mass was found, the size of a large pumpkin, over which was plastered on the lower

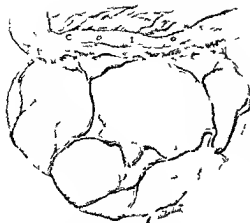


Fig. 1. Tumor mass as seen by artist at operation

the stomach and intestines two sets of nervous plexuses: one is located in the submucous plexus (Meissner), the other between the annular and longitudinal muscular planes of the stomach with clusters of ganglion cells at nodal points (Auerbach). Schwannoblastoma originates in the myenteric plexus of Auerbach from the sheath of Schwann. Since the nerve sheath has a dual origin: ectodermal and mesodermal, the histological picture of schwannoma may be classified either as ectodermal (v. Recklinghausen) or mesodermal (Verocay). Penfield, in American literature, rejects the ectodermal origin.

Schwannoma is usually a small tumor, but may attain a large size if there is anatomical chance for expansion. As a rule, it is single, exceptionally multiple. Occasionally, it is associated with multiple cutaneous fibromatosis (von Recklinghausen's disease). Schwannoma has a preference for centrally located tissues, whereas neurofibroma prefers the periphery. Schwannoma often invades the spinal cord roots, especially the posterior. It is often found in the root of the acoustic nerve, especially its peripheral branch (Henschen, Cushing). The tumor is well encapsulated and while it may displace other tissues it does not infiltrate. It is soft on cut surface, its color varying from brown to gray. Here and there areas of cystic degeneration with colored fluid and cystic spaces, brownish spots, evidence of old hemorrhage. Gastric schwannoma grows peripherally and if it encroaches upon the lumen of the stomach it does not as a rule ulcerate the gastric mucosa. In Gosset's collection of 42 cases of gastric schwannoma, there was no involvement of the mucosa in

21 cases. Some cases, however, ulcerate the mucosa and cause hemorrhages, as it occurred in the case of Lemonnier and Peycelon. In the case of Dupuy the neurinoma caused both ulceration of the mucosa and perforation of the gastric wall. The tumor may be situated on the anterior wall either intramurally or subserous.

Schwannoma is essentially a benign tumor. It is well encapsulated and while it may recur *in situ* it does not as a rule become malignant or metastasize. The tumor is often pedunculated, grows slowly, and does not impair the patient's health, which explains its long latency.

In the case of Paul Carnot there were metastases in the heart. Kurt Denecke reported 2 cases of schwannoma from the Pathological Institute of the University of Freiburg: one in the duodenum, the other in the stomach, both of which were malignant and metastasized in the liver.

Clinically schwannoblastoma of the abdomen is characterized by a long period of latency and the presence of a mass in the upper abdomen located medially. There is no pain or discomfort except if there is interference with neighboring organs by sheer pressure. In Gosset's collection there were no gastro-intestinal symptoms in 27 cases. However, in a number of cases the patients had gastro-intestinal symptoms which simulated gastric ulcer and in a few a penetrating ulcer. In the intestines schwannoma is more apt to ulcerate and cause intestinal hemorrhages.

The presence of a mass in mid epigastrium expressed in terms of gastric ulcer in association with von Recklinghausen's disease is highly suggestive of schwannoblastoma.

Antoni, taking into account the histological pattern, describes two types of schwannoblastoma.

Type A (Antoni). *Fibrillary type*, made up of long slender fibers, either straight or undular, regularly grouped, cells with elongated nuclei arranged in palisades, whorls, similar to those seen in meningiomas. Type A is a neurofibrinous structure at the height of its development.

Type B (Antoni). *Reticular type*, made up of fibers and cells without orderly arrangement, cysts and spaces filled with fluid. Type B indicates retrogressive changes and degenerative phenomena and is a sort of jellyfication of Type A.

Both types show unequal distribution of capillaries with evidence of dilatation, thrombosis or hemorrhage.

In addition to the diagnostic earmarks given in ray pictures may show a round shadow with a depressed area, suggesting a penetrating ulcer. In the differential diagnosis one has to consider



Fig 5 Histological appearance of tumor, low power



Fig 6 Histological appearance of tumor, high power

from the ganglionic crest, which have not differentiated."

**Symptomatology** Sympathetic tumors may be silent for a long time and are often discovered quite accidentally in the course of a systematic physical examination. They give rise to clinical symptoms by interference with the function of neighboring organs with which they are in intimate contact. They may compress or infiltrate

neighboring veins, as it happened in our case, and may be the first clinical evidence of pelvic or abdominal compression by a tumor mass. Edema of one or both legs of unknown origin, and in the absence of thrombophlebitis, calls for a careful examination of the pelvis.

**Diagnosis and differential diagnosis** One has to differentiate these tumors from other intraperitoneal or retroperitoneal tumors. The simple



Fig 7 Lymph node with neoplastic infiltration

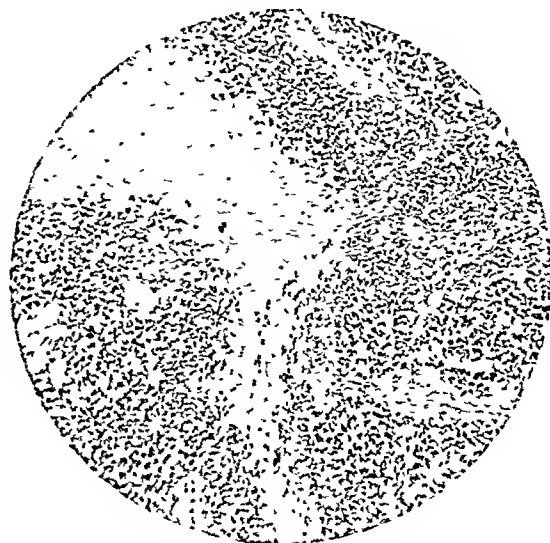


Fig 8 Histology of tumor embolus in right auricle





Fig 4 Schwannoblastoma. Histological appearance of segment of tumor

border and on the outer surface a segment of transverse colon in hot shoe fashion. The mass was lobulated and had very large tortuous veins on its surface. On further investigation it was disclosed that the mass was located in the gastrocolic omentum being attached rather firmly to the stomach wall at one point. In the attempt to free the mass from the surrounding structure there was a good deal of hemorrhage from the greatly distended veins. The gall bladder came close to the outer margin of the tumor but was not attached to it. The wall of the gall bladder was very thick. As a matter of fact the gall bladder was a solid mass (Fig 1).

Although the situation looked somewhat spectacular at first there was no difficulty in freeing the tumor except for the attachment to the stomach and the intimate connection of the colon which as described covered the lower and outer surface of the mass. It was necessary to remove a segment of the stomach to separate the tumor from it the gastric defect being closed in the usual manner. The colon could not be freed without obvious injury to its walls and blood supply. It was therefore divided a short distance beyond the tumor circumference after which an end-to-end anastomosis was made. A drain was placed in the upper abdomen which was closed in the usual manner (Figs 2 and 3).

The patient had a very stormy convalescence and at times seemed to be in a hopeless state. Yet with the assistance of numerous cardiac stimulants several blood transfusions and meticulous postoperative care on the

part of the internes the patient eventually made a fairly good recovery. During convalescence there was some drainage from the upper part of the wound which was due to colon bacillus infection. Wet dressings frequently applied cleared up the infection within a short time.

**Pathological report.** The specimen consists of a huge tumor mass removed by located in the gastrocolic omentum to which was attached a portion of the transverse colon. The latter was markedly adherent to the mass which did not communicate with the lumen. However the muscularis was firmly adherent in places. The colon measured 18 centimeters in length. The tumor mass measured 12 by 10 by 17 centimeters in the greatest dimensions. On section it was found to be composed of light yellowish gray tissue mixed with purple red. The portion of the tumor mass which was attached to the large bowel was grayish white with a central liquefaction which was also filled with blood stained material.

**Microscopical report.** Section of the tumor with attached transverse colon revealed an intact mucosa submucosa and muscularis. Attached to the serosa and intimately adherent to it was a large tumor mass composed of islands of elongated cells resembling epithelium with slightly irregular nuclei containing a granular chromatin. The cytoplasm was eosinophilic and granular. The cell borders were indistinct. These islands and cords of cells were separated from each other by a pinkish to bluish staining fibrillated and vacuolated substance. In the more dependent portion of the tumor away from the colon these cells were transformed into spindle and stellate forms with much intercellular fibrillary stroma. In this portion of the tumor mass only occasional islands of the previously described cells were seen. The capillaries were few thin walled congested and in places surrounded by small focal hemorrhages (Fig 4).

**Diagnosis.** Schwannoblastoma, a tumor derived from the sheath of Schwann from its cells or nerve fibers. Histologically there is but slight evidence of malignancy chiefly in the form of mitotic figures.

#### SYMPATHICOBLASTOMA (NEUROCYTOMA)

Reid and Andrus define this type of tumor as a highly malignant tumor arising from undifferentiated cells of the primordium of the autonomic and chromaffin system.

It is stated that Hueter in 1905 was the first to recognize these neoplasms as being glial tissue and he, therefore classified them as nervous structures. Hueter's histological studies revealed that the fine fibers did not stain red with van Gieson's stain but yellow and that the pattern of reticulation resembled those of glioma.

According to Herzheimer, who collected all cases up to 1914 the first case was described by G Parker.

The nomenclature of these tumors varies according to the histological pattern and to the examiner's interpretation and preference. We therefore encounter the following terminology: neurocytoma, sympathicoblastoma (Pick, Brelschowsky, Wright), ganglioma embryonale sympathicum (Pick), sympathicogonioma (Herzheimer). Bailey and Cushing prefer the term sympathicoblastoma a tumor made up of wandering cells

Pick, on the basis of histological pattern, distinguishes two types (a) cellular (b) fibrocellular. In the first instance, the cells arrangement may be either diffuse or alveolar, in the second instance, one finds palisades.

*Treatment* I am as unfamiliar with the sensitivity of these tumors to x-rays or radium, as are radiologists and radium therapists. Surgeons will usually decide upon removal when the tumor is discovered. In my only experience with such neoplasms, I was stunned by the great tendency of the tumor to extensive hemorrhages at the slightest touch and the utter helplessness of controlling a massive hemorrhage, even though the tumor is well encapsulated and free from neighborhood attachments.

# ABSTRACT OF CLINICAL HISTORY

M. G., age 51 years, female, white, was admitted to hospital January 10, 1938, and died January 13, 1938.

The history revealed sudden onset of unilateral edema of the right leg of 6 weeks' duration. She had not noticed any change in temperature, color, pain, or local symptoms other than pitting edema. She was treated locally with slight improvement. One week prior to entrance a mass was found in the abdomen. The patient had not noticed this previously and had had no symptoms referable to the mass. The patient did not suffer from loss of weight, anorexia, or change in bowel habit. There were no gastrointestinal symptoms. She had a gradual decrease in frequency of menses for the past 2 years and at the present time they occurred every 4 to 6 months, with moderate flow. There was no intermenstrual bleeding. The remainder of the history was essentially negative.

*Physical examination* The head, neck, heart, and lungs, were negative. There were no adenopathies. The blood pressure was 150/84. The abdomen showed marked distention recti through which it was easy to palpate a large, firm, round mass, about the size of a large orange, in the right lower quadrant about the level of the ovary. It was somewhat fixed to deeper structures and not tender to touch. Vaginal and rectal examinations were not done. There was present pitting edema of the right leg to the thigh. There was no tenderness or temperature change. The blood count showed, hemoglobin, 90 per cent, red blood cells, 4,500,000, white blood cells, 7,600, polymorphonuclears, 63—band forms, 1, small lymphocytes, 38, monocytes, 2. The urine was negative.

On January 11, she was sent to x-ray department for a flat plate and barium enema.

On January 13, under general anesthesia a midline incision was made. A large retroperitoneal mass was found in the right lower quadrant. In attempting to remove it, massive hemorrhage was incurred. The patient's blood pressure dropped to systolic of 50 and the pulse was imperceptible. She was given stimulants, saline, gum acacia, and 500 cubic centimeters of whole blood. Three packs were inserted and the patient taken to room and put in oxygen tent. The pulse and blood pressure never picked up. Despite further shock therapy, the patient expired at 10 55 a. m.

*Summary of postmortem examination* The clinical diagnosis was retroperitoneal neurocytoma, surgical shock.

Gross anatomical diagnosis—	Histological diagnosis
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Tumor embolus in right auricle	Sympathicoblastoma
Thrombus in vena cava inferior—	Sympathicoblastoma
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Anemia	
Spleen Acute anemia	Acute passive congestion
Liver Acute anemia	
Kidneys Hydronephrosis (right)	Acute passive congestion
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*Autopsy* Microscopic examination of the sections of the lung tissue showed extensive atelectasis. In the liver sections were small accumulations of lymphocytes in the interacinar connective tissue. The yellow nodule in kidney was due to the presence of adrenal cortical tissue. No evidence of malignancy was found in the rectal polyp. A diffuse infiltration with tumor tissue of the same structure as seen in the primary tumor was noted in some of the lymph nodes. The other lymph nodes showed marked hyperplasia of the reticulo-endothelium and foci of calcification.

Sections of the tumor mass specimen show a very cellular growth with extensive hemorrhages. The cells show very scanty cytoplasm and medium size oval shaped nuclei with an abundant amount of chromatin that is finely distributed. Between the cells there are present fine, very indistinctly staining fibrils. The connective tissue stroma between the cell accumulations is not very abundant. The vascularization is very rich. The cells are arranged in very dense layers around the blood vessels. The structure is in every way identical with the structure reported in the retroperitoneal tumor removed at operation on January 13, 1938. The picture is that of a neurocytoma or sympathicoblastoma.

A thrombus was present in vena cava inferior. Sections of the psoas muscle show infiltration of muscle tissue with tumor tissue. An embolus in the heart was of identical structure with the structure of the tumor. Figure 8 illustrates the histology of a tumor embolus.

test of inflating the rectum and sigmoid with air will often help in determining whether the tumor is intraperitoneal or retroperitoneal. If the tumor disappears after inflation, and the percussion note, heretofore flat or dull, becomes resonant the tumor is retroperitoneal. The following tumors have to be differentiated from sympathicoblastoma: hypernephroma, chloroma, osteosarcoma, lymphogranuloma. Kidney tumors may be differentiated by either intravenous or retrograde pyelograms.

Röntgenograms, while not diagnostic as to the nature of the tumor, reveal the presence of a tumor shadow and are especially valuable if the tumor is located in the chest.

**Pathology.** Sympathicoblastoma is found in newborn, premature, and in very young children. Exceptionally, it may be found in adults in which case it represents the more mature type of tumor. The case of Barneitz was a woman 37 years old. Our case was a woman 51 years of age. Jaffe's case was a woman 37 years old. The cases seem to occur more often in women (Landau). The tumor originates either from the adrenal medulla, or less commonly from the sympathetic plexus, sympathetic ganglia, or paraganglia. It may be found in the chest, neck, or abdomen. In the neck it may originate from the cervical ganglion or it may be metastatic from a suprarenal tumor (Blacklock). Shuzuo Tsunoda reported multiple tumors of various sizes in the terminal jejunum which proved to be sympathicoblastomas. John Norcross reported 4 cases rarely encountered in the practice of orthopedic surgery. One was a girl, 18 months old, who had a tumor within the spinal canal at the level of the ninth thoracic vertebra, extending into the thoracic cavity. The second case a boy of 9 with a tumor at the costovertebral junction of the third rib, extending into the spinal canal. The third case a boy of 6, with a tumor in the mediastinum. The fourth case, a girl, 5 years old with a mass in the abdomen to the left of the spine. All four tumors proved to be sympathicoblastomas. H. H. Schmid in a collected survey of 267 cases of retroperitoneal and mesenteric tumors, found 10 ganglioneuromas. Stoeckel in a survey of pelvic tumors up to 1913 found only a couple dozen of pelvic tumors of sympathetic origin. The tumor varies from the size of a walnut to that of a child's head. It may compress the tissues in the vicinity. It has a tendency to form thrombi in large vessels, infiltrate, bleed extensively, and metastasize. The histologically mature type seldom metastasizes, whereas the immature type metastasizes in the liver, lymph nodes, orbit, and occasionally the spleen.

From the standpoint of malignancy, the tumor may be classified according to its clinical tendencies or according to the histological pattern. Clinically, two types have been described:

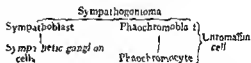
1. Pepper type giving metastases in lymph nodes and liver. Clinically the patient has a large and painless abdomen and a large liver.
2. Hutchinson type giving metastases in bones especially skull. Clinically the patients have ecchymoses and exophthalmos.

Histologically, there are several classifications. Karl Rapius classified sympathicoblastoma as follows:

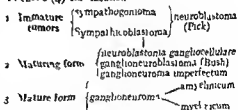
1. Immature form (sympathetic neuroblastoma, sympathogonioma, sympathicoblastoma)
2. Maturing form (ganglioneuroblastoma)
3. Mature form (ganglioma)

Sympathicoblastoma although made up of immature forms, may occasionally show other types and transitional forms from primitive neuroblasts to mature ganglionic cells (Pick, Landau). Wahl reported a case of mixed neurogenic elements.

Poll and Pick's classification



Wahl's (4) classification



Because of the presence of small round cells, these tumors have been occasionally designated as small round cell sarcoma. We encountered such terms as lymphosarcoma (De Ruyter) or round cell sarcoma (Heaton Wilke) or hemorrhagic sarcoma (Bruch).

**Histopathology.** The average pattern is made up of round cells a little larger than a lymphocyte, arranged in rosettes with a stroma of finely interlaced fibrillae which take a silver stain. Herzfeimer using Bielschowsky's stain was the first to find axones in stroma. According to Marchand the cells are arranged either in clumps or in alveolar fashion. The grouping of cells often resemble glands around a lumen. The small cells have hyperchromatic nuclei and little cytoplasm.

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## BIBLIOGRAPHY

*Schwannoblastoma*

- 1 ANTONI, N R T Ueber Rückenmarkstumoren und Neurofibrome Muenchen 1920
- 2 BALFOUR D C and HENDERSON E F Ann Surg 1917 85 354
- 3 CARNOT I Ann de med et de chir 1928-1929 1 37
- 4 DUFFY M Internat Clin, 1928 35th ser vol 4 164
- 5 ELIASON E L and WRIGHT V W M Surg Gynec & Obst 19 3 41 461
- 6 GOSSET A J de chir 1924 23 577
- 7 JENTZER Iye eméd 1923 31 827
- 8 LEMONNIER and IFVCELON Bull et mêm Soc nat de chir 1913 59 1318
- 9 MASSON I Compt rend Acad d sc, 1921 173 262
- 10 ONKELS H Ugesk f Læger 1927 89 185
- 11 PERET L Zentralbl f Chir 1930 57 2475
- 12 PETERSEN, DUGGIE L Tinska lak salssk handu 1926 79 133
- 13 STOLT A P Am J Cancer 1928 24 751
- 14 VEROLAY JOSÉ Beitr z path Anat 1910 48 1

*Sympathicoblastoma*

- 1 BAILEY, I and CUSHING H Tumors of the Glioma Group Philadelphia J B Lippincott 19 6
- 2 BARNEWITZ Frankfurt Ztschr f Path 192 26 317
- 3 BLACKLOCK J W S J Pathol and Bacteriol, 1934 39 27
- 4 FISCHER V Handbuch der Neurologie Vol 9 p 230
- 5 HERXHEIMER G Beitr z path Anat 1914 57 112
- 6 JAFFE R H Beitr z path Anat 1910 65 363
- 7 KAFSTER H Arch f path Anat 1905 180 117
- 8 NORCROSS J R Proc Inst Med 1938 12 163
- 9 LARKER Quoted by Bulbring Arch f path Anat 1928 268 300
- 10 FOLL and LUCK Handbuch der Neurologie Vol 9 p 230
- 11 REID M R and ANDRÉS W DEW Dean Lewis Fracture of Surgery 1934 vol 3 chap 4 p 13
- 12 RUPILLIS K Ztschr f Kinderheilk 1933 55 709
- 13 SCHMID H H Arch f Chir 1923 118 490
- 14 STOLCKEL W Zentralbl f Gynæk 1921 47 13
- 15 TAYLOR S Tr Japan Path Soc 1931 21 845
- 16 WAHL H R J Med Research 1914 30 205

# THE INJECTION TREATMENT OF HERNIA

H. O. WERNICKE, M D, Chicago, Illinois

IN the last few years much has been written about the injection treatment of hernia. The glowing reports of complete cures of all types of hernia, even up to 100 per cent, have been very enthusiastic. This enthusiasm, unfortunately, has resulted in a wholesale onslaught on all kinds of hernias with various types of injection solutions. The indiscriminate use of these irritating solutions by those unskilled in the technique is apt to produce serious consequences. Hernias are being injected by hundreds of physicians who would not attempt surgical repair because of their lack of knowledge of the anatomy of the inguinal region and the surgical technique. Yet these same physicians will take chances on introducing a strong irritant into a human body with the hope that it will get into the proper place, and will not cause gangrene and perforation of a loop of bowel, followed by peritonitis and death. These accidents probably have occurred many times, with fatal results, but the literature records very few accidents of this type.

Berne has recently reported 2 deaths following the injection of the solution into the bowel wall with resulting gangrene, perforation, and peritonitis. Neither of these patients was injected by him. He mentions 2 others reported by Fowler. Berne also quotes Harris and White as having averaged 1 intraperitoneal injection in every 20 patients treated. But the literature, in most instances, minimizes the dangers of the injection treatment and leaves the impression that even the intraperitoneal injection of a proliferating solution is not of serious consequence. Berne's article is a timely and valuable contribution. Personal experience with complications in over two thousand injections has been quite meager. However, it might not have been if the very important precaution of always aspirating before injecting had been neglected. One patient had severe pain in the right pelvis a few minutes after an injection on the left side at the internal ring. The pain lasted about 15 minutes and was so severe that she could not lie still, rolling about on the table. Fortunately, she had no further trouble after leaving the clinic. Blood has been aspirated on 3 occasions when the needle was inserted at

the neck of the sac. The needle was withdrawn without injecting any solution, and there was no reaction. Edema of the cord is not infrequently seen, but it is not serious. Delayed pain has been complained of by a few who reported inability to work for 2 or 3 days after an injection. One abscess was encountered several days after an injection. It was incised and drained outside the hernia clinic. No culture was taken, and it is therefore unknown whether the content was sterile or infectious.

Berne rightly speaks of the greater danger of entering the peritoneal cavity when the needle is deeply introduced, and yet it appears necessary to make deep injections at the neck of the sac if the hernia is to be permanently obliterated. If the needle, while being introduced deep at the internal ring, suddenly meets with absolutely no resistance at all, and if aspiration reveals nothing, it must be suspected of having entered the peritoneal cavity and should be withdrawn to the point where resistance is encountered. This procedure will prevent injecting the irritant into the peritoneal cavity, and thereby remove the greatest danger connected with the treatment.

Bratrud mentions 2 cases seen in consultation in which the deep epigastric artery had been injected, with slough near the umbilicus. He also reports the case of a patient, treated elsewhere, who died as a result of intraperitoneal injection with perforation of the ileum and peritonitis. One of his own patients who was immediately operated upon because of severe abdominal pain following an injection showed no signs of peritonitis. All patients who experience severe abdominal pain after an injection, however, should be treated as potential peritonitis cases, and kept under observation until their symptoms have disappeared.

McKinney reported 2 strangulations due to the truss, one in a woman after fifteen injections, the other without injection. In consultation he also saw a patient who developed thrombosis or embolism of the anterior tibial artery with loss of a toe on the same side following an injection, and another who developed an abscess as a result of injection of the solution into a blood vessel of the spermatic cord. One of his patients had an abscess following injection for a recurrent hernia after appendectomy. These less serious accidents

From the Department of Surgery, University of Illinois College of Medicine, and the Hernia Clinic of Illinois Research and Educational Hospital.

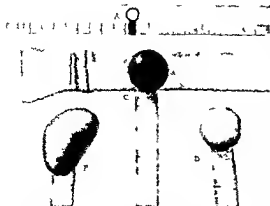


Fig 1 A Transparent ruler with slide ring B The pad of the injection truss attached to the perineal band which in turn slides on the abdominal band for adjustment to right or left This pad covers internal ring and inguinal canal and does not press on symphysis C Test truss with moderately thin pad used in most cases It is 1 5 inches in diameter It is shown on the abdominal band of short stretch webbing D Test truss with thicker pad on perineal band for use in heavier subjects More pressure can be obtained with this pad when tightening the hernia

caused confinement of the patients in the hospital from a few days to a few weeks Another patient with symptoms of local peritonitis following injection for recurrent hernia was operated upon, and a small area of local peritonitis was found

Rice reported 12 instances in a series of 445 cured cases, of peritoneal irritation and 66 minor complications including 3 local abscesses It is therefore obvious that the injection treatment of hernia is not devoid of serious and even dangerous complications and sequelae in the hands of skilled operators As Bratrud says There is a definite technique and unless this is learned great harm may result This cannot be too strongly emphasized

Although the literature has apparently been quite extensive and comprehensive it still appears advisable further to emphasize the fact that the injection treatment of hernia is not as simple as giving an ordinary hypodermic injection It would appear that the rules for the proper selection of cases have not been stated definitely enough for the guidance of those only occasionally using the method The indications for the injection treatment of hernia should be more specific and, as explained below, should be fewer Heroin, which do not fulfill certain requirements should not be injected McKinnon advises that "the

small hernia in the young individual offers the ideal case for treatment by this method" Bratrud appears to be too inclusive when he makes the statement that "umbilical, indirect inguinal direct inguinal, and recurrent hernia give the best results," and in stating further that "laying aside the contra indications, it may be said that any inguinal hernia can be treated provided that it is reducible and can be held reduced by a properly fitting truss, and provided that there are no surgical contra indications" Wangenstein remarks that "the selection of appropriate cases is extremely important The small reducible, indirect hernia in the young person with strong tissues seems most suitable for this method of treatment An anxiety to extend the method to cases that present large defects and poor tissues results in a large incidence of failures" However it still seems advisable to limit the indications for the selection of cases even more definitely When a hernia is a "selected" one it should be one which is shown by experience to respond consistently to treatment In the author's opinion the injection treatment of hernia should be limited to the small indirect inguinal hernia which fulfills the indications to be described later Other types of hernia may, and occasionally do, yield to treatment The indirect inguinal hernia should have a greater prospect of cure because of the length and anatomical characteristics of the canal If the canal can be obliterated the hernia can be cured In most other hernias the success of treatment depends on filling in or covering over the weak place in the abdominal wall with a layer of scar tissue Scar tissue is weak tissue and will become weaker as time progresses particularly as atrophy takes place A defect cannot be filled or covered with scar tissue strong enough to prevent herniation This is also the opinion of Crohn, and of Burdick and Coley

#### THE "SELECTED CASE"

The selection of a hernia for injection treatment at the hernia clinic at the University of Illinois depends very definitely on the fulfillment of the following positive indications

- 1 Must be indirect inguinal
- 2 Must be completely reducible
- 3 Must be held reduced by test truss (see C and D Fig 1)
- 4 The external ring must be no larger than a nickel (2 centimeters in diameter)
- 5 The external oblique aponeurosis at the external ring must not be thinned out or shredded
- 6 The inguinal canal must be at least 1 inch in length



Fig 2 The anterior superior spine of the ileum and the spine of the pubis are marked with tincture of iodine. The slide ring is set on the transparent ruler half way between the two marks and iodine is applied within the circle. This locates the internal ring. This young man has no hernia on the side being marked, but was picked at random to demonstrate the method of locating the internal ring



Fig 3 The skin over the internal ring is marked with tincture of iodine and ready for injection

7 The patient must be in otherwise good health and of at least average co-operative mentality

If these indications are observed there is no need of listing contra-indications, which have been voluminous. An epileptic might escape indication 7 unless a careful history is taken, obviously if the patient should have a convulsion during the injection a serious accident might be sustained. It is our opinion that only those hernias which fulfill the indications mentioned should be given the injection treatment. All others should be treated surgically or with a truss alone

#### EQUIPMENT NEEDED

The syringe may be either the tuberculin or ordinary Luer type. The needle should be 22 gauge, an inch and a half in length, and with a bevel decidedly shorter than the standard short bevel. This allows more delicate feel in going through the various layers of fascia and muscle. The solution used in our clinic is the phenol-alcohol-thuja mixture. A transparent ruler with a sliding ring (A, Fig 1) has been of great convenience in determining the location of the internal ring. A "test truss" (C and D, Fig 1) is used in selecting each new case which has already fulfilled the other positive indications and thought to be suitable for the treatment. It consists of a firm pad an inch and a half in diameter, built on short stretch webbing, and can be adjusted to either right or left side. It is made with either of two pads (C and D as shown in the illustration), the thicker one being used in the heavier subjects. After the internal ring is marked with the aid of the slide ring and ruler the "test truss" pad is ad-

justed over it, the belt is tightened, and the perineal band is fastened. Then the patient tries to make the hernia descend by bearing down, coughing, and stooping. This test determines whether or not the case fulfills indication 3. The "injection truss," which is worn day and night by a patient receiving injections, is composed of two parts—an abdominal band of "short stretch" webbing and a perineal band of softer webbing which embraces the pad. The pad is attached in the front of a loop at one end of the perineal band. This loop slides on the abdominal band to allow adjustment of the pad to right or left, and is anchored to the abdominal band with needle and thread when the pad is properly placed over the internal ring. The type of pad on the "injection truss" is shown (B, Fig 1) in the illustration, attached to the perineal band. The abdominal band is an inch and a half wide. It is made of "short stretch" webbing which is so constructed that it will stretch only one inch to each foot of webbing. This is just enough to allow body freedom without allowing the pad to shift in position or relax in pressure. This truss has been found to be most satisfactory for those receiving the injection treatment because it stays in place at all times and in all positions, even when the patient lies on his back. No patient has yet complained that this truss, when properly fitted, has been uncomfortable. The "injection truss" is worn continuously for a week before injections are started, and must have held the hernia completely during all that time.

#### TECHNIQUE

The patient, lying flat on his back, removes his truss without straining. He is taught how to do this so that he may remove the truss for sponge baths to keep the skin and pad clean. The inguinal region is examined to make sure that the



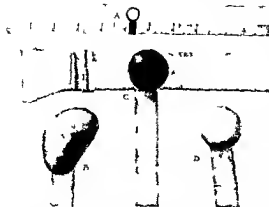


Fig 4. A Transparent ruler with slide ring. B The pad of the injection truss attached to the perineal band which in turn slides on the abdominal band for adjustment to right or left. This pad covers internal ring and inguinal canal and does not press on symphysis. C Test truss with moderately thin pad used in most cases. It is 2 1/2 inches in diameter. It is shown on the abdominal band of short stretch webbing. D Test truss with thicker pad on perineal band, for use in heavier subjects. More pressure can be obtained with this pad when testing the hernia.

caused confinement of the patients in the hospital from a few days to a few weeks. Another patient with symptoms of local peritonitis following injection for recurrent hernia was operated upon and a small area of local peritonitis was found.

Rice reported 12 instances in a series of 445 cured cases, of peritoneal irritation and 66 minor complications including 2 local abscesses. It is therefore obvious that the injection treatment of hernia is not devoid of serious and even dangerous complications and sequelæ in the hands of skilled operators. As Bratrud says, 'There is a definite technique and unless this is learned great harm may result.' This cannot be too strongly emphasized.

Although the literature has apparently been quite extensive and comprehensive it still appears advisable further to emphasize the fact that the injection treatment of hernia is not as simple as giving an ordinary hypodermic injection. It would appear that the rules for the proper selection of cases have not been stated definitely enough for the guidance of those only occasionally using the method. The indications for the injection treatment of hernia should be more specific and as explained below, should be fewer. Hernias which do not fulfill certain requirements should not be injected. McKinney advises that 'the

small hernia in the young individual offers the ideal case for treatment by this method.' Bratrud appears to be too inclusive when he makes the statement that 'umbilical, indirect inguinal direct inguinal, and recurrent hernia give the best results,' and in stating further that 'laying aside the contra indications, it may be said that any inguinal hernia can be treated provided that it is reducible and can be held reduced by a properly fitting truss, and provided that there are no surgical contra indications.' Wangenstein remarks that 'the selection of appropriate cases is extremely important. The small reducible, indirect hernia in the young person with strong tissues seems most suitable for this method of treatment. An anxiety to extend the method to cases that present large defects and poor tissues results in a large incidence of failures. However it still seems advisable to limit the indications for the selection of cases even more definitely. When a hernia is a "selected" one it should be one which is shown by experience to respond consistently to treatment. In the author's opinion the injection treatment of hernia should be limited to the small indirect inguinal hernia which fulfills the indications to be described later. Other types of hernia may, and occasionally do, yield to treatment. The indirect inguinal hernia should have a greater prospect of cure because of the length and anatomical characteristics of the canal. If the canal can be obliterated the hernia can be cured. In most other hernias the success of treatment depends on filling in or covering over the weak place in the abdominal wall with a layer of scar tissue. Scar tissue is weak tissue and will become weaker as time progresses particularly as atrophy takes place. A defect cannot be filled or covered with scar tissue strong enough to prevent herniation. This is also the opinion of Crohn and of Burdick and Coley.

#### THE SELECTED CASE

The selection of a hernia for injection treatment at the hernia clinic at the University of Illinois depends very definitely on the fulfillment of the following positive indications:

- 1 Must be indirect inguinal
- 2 Must be completely reducible
- 3 Must be held reduced by test truss (see C and D Fig 1)

4 The external ring must be no larger than a nickel (2 centimeters in diameter)

5 The external oblique aponeurosis at the external ring must not be thinned out or shredded

6 The inguinal canal must be at least 1 inch in length



Fig 5 At left, 2 weeks following injection of Solution II This solution has produced a dense scar of fibrous connective tissue, *c* Reactive vascular centers *v*, *v*, are seen throughout the scar already formed, with others in the surrounding subcutaneous fat, *f* At right, 4 months after injection of Solution II (thuja mixture) This scar tissue has persisted 4 months and is therefore twice as old as that described in Figure 4, right The fibrous connective tissue, *c*, shows beginning resorption with fat infiltration, *f* How-

ever, the connective tissue strands show considerably more viability and cellularity than those seen in Figure 4, right There is also evidence of continued reaction about the vascular centers, *v*, indicating that perhaps more scar will be formed Histologically one may conclude Solution II produces more lasting scar than Solution V Since duration of scar is of prime importance, Solution II should be considered the best of those solutions which were tested in this experiment

ward, and ending with the tenth dose one-half inch above the external ring The external ring is usually obliterated by this time and is rarely treated Ten injections are sufficient for most cases Some require 2 or 3 more But when 20 to 40 are necessary it would seem that the case had not been well selected and that operation should have been done

#### POST-INJECTION MANAGEMENT

One month after his last injection the patient returns for examination If all is well he removes his truss at night for the next month, wearing it only during the day If it is still holding satisfactorily at the end of this second month he is allowed to remove the truss entirely He is advised against only one thing—heavy lifting Otherwise he may pursue his regular and customary habits At the end of the next month, if there is no sign of hernia, he is allowed to go 2 months before being examined He is examined at intervals of 2 months until he has remained free from recurrence for one year after the truss has been discarded Then he is considered cured

#### RECURRENCE AND SCAR ABSORPTION

Every hernia carefully selected for the injection treatment is apparently cured at the time of the second month checkup following the last injection At this time the truss is discarded both day and night Four to 6 months later, a small percentage of these cases show a weakening at the site of the hernia, or even an actual recurrence It has been

noted that those cases which survived this period of potential recurrence remained cured This suggests that absorption of the scar tissue is the probable cause of recurrence Animal experiments confirm this suspicion Recurrent cases were given a complete new course of 10 treatments, usually with satisfactory results Those with merely a weakness in the inguinal region were given 2 to 4 additional injections

#### ANIMAL EXPERIMENTS

Six different solutions were used in the experiment The dogs were injected at 6 different places on the back and at one point in the rectus muscle with each solution No attempt was made to determine the immediate effects of the various solutions because this has been done by other investigators with conclusive evidence of their scar-producing effects Proof is not lacking that mature scar tissue is formed within 4 to 6 weeks after the solution has been injected But most workers have seemed to be satisfied with the knowledge that good scar tissue was formed within a given time without continuing the experiment far enough to determine how long the scar would last

Biopsies were made at periods of 2, 4, 6, and 8 weeks, and then at 3 and 4 months The results are shown in the summary of experimental work (Table I), and in the photomicrographs (Figs 4 and 5) In the first biopsies (2 weeks after injection treatment), Solution V had produced the best early scar tissue, but absorption began as



Fig. 4. Left 2 weeks following injection of Solution V as noted there is a deposition of dense scar tissue. The fatty subcutaneous tissue *f* is shown being replaced by fibrous connective tissue *c* which is being formed from the proliferation of round cells, histiocytes and fibroblasts arising



about the numerous vascular centers *v*. Right 8 weeks following injection of Solution V. The scar tissue is now hyaline in character, relatively acellular and broken up into thin strands. Fatty infiltration *f* is producing resorption of the scar.

hernia is being held by the truss. This is done before every injection as a precaution against injecting into a loop of bowel or other possible content of a hernial sac, and cannot be too strongly emphasized. The first injection is given deep at the internal ring. To make as accurate as possible the location of the internal ring is the function of the transparent ruler with slide ring, said ring being 1 centimeter above the edge of the ruler. The anterior iliac spine and the spine of the pubis are spotted with tincture of iodine. The distance between them is measured with the ruler, the slide ring adjusted half way between, and iodine is applied within the ring. This definitely marks the location of the internal ring (Figs. 2 and 3 illustrate the technique). The site of injection is prepared further with tincture of iodine, the syringe is loaded with the proper amount (8 minims) of solution plus a small amount of air for cleaning the needle at the end of the injection.

With the syringe held vertically the needle is inserted perpendicularly through the skin. The point then rests on the aponeurosis of the external oblique which offers firm resistance. The introduction of the needle through the aponeurosis requires enough pressure so that a distinct lack of resistance is felt as soon as the tip of the needle has penetrated it. The internal oblique and transversalis muscles must now be penetrated before the internal ring is reached. Here the sensation is less pronounced than when the needle passed through the aponeurosis and concentration is required to determine exactly the point at which these muscles have been penetrated and the transversalis fascia reached. It is at this location that the solution is to be deposited. But first—as

pirate! There should be at least slight resistance to the needle tip if the deep epigastric artery or peritoneal cavity have not been entered. The depth of the needle point at the neck of the sac is usually between an inch and an inch and a quarter. In very heavy subjects it is more. A minute amount of solution is injected slowly. If some of it enters the sac it may seep into the peritoneal cavity. This would cause severe pain in which case the needle should be withdrawn without injection of more solution. If there is no severe reaction after a few seconds the remainder of the solution is injected and the air in the syringe is forced through to clean the needle. This reduces the likelihood of dragging the irritant through the tissues when the needle is withdrawn and eliminates the formation of subcutaneous nodules. Theoretically a minute amount of the solution injected into the empty sac near its neck would produce sclerosis at the most desirable site, but injecting the entire contents of the syringe at this point might cause intraperitoneal complications. If the patient should complain of abdominal pain during the first part of the injection no more of the solution should be injected at that time. Firm pressure with an alcohol sponge is main-  
tained over the site of injection for about 30 seconds after removal of the needle. The patient replaces his truss without straining.

#### FREQUENCY AND NUMBER OF INJECTIONS

An injection is given once a week for 10 weeks. The first 6 are given deep at the internal ring. The last 4 are given along the inguinal canal just beneath the aponeurosis of the external oblique beginning over the internal ring proceeding down

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Among the first type of operations, arthrodesis of the talonavicular joint by excision of the articular cartilage is the simplest. This procedure has a low degree of efficiency so that Soule modified it by inserting a bone peg through the navicular bone into the head of the talus. Hoke mortises a section of the cortex of the tibia between the adjoining surfaces of the navicular and first cuneiform bones after lengthening the tendocalcaneus. The arthrodesis includes the joint between the navicular and the second cuneiform bones. Miller performs an arthrodesis of the navicular-cuneiform and the first tarsometatarsal joints. In this operation he also transplants and shortens the tendon of the tibialis posterior muscle.

As an example of the tendon operations, plastic lengthening of the tendocalcaneus to relieve the contracture of its muscles as a deforming factor, is performed as part of nearly all flatfoot operations. However, lengthening of the tendocalcaneus and follow up exercises are not sufficient to expect improvement of the arch to any great extent.

Lowman combined arthrodesis of the talonavicular joint with redirection of the tibialis anterior tendon posterior to the navicular bone in the space between the latter and the talus. In this operation the insertion of the tibialis anterior was not detached. Later he modified the procedure by re-enforcing the ligaments on the medial side of the tarsus with a transplant from the tendocalcaneus or the plantaris tendon. Lord modified the Gleich (2) osteotomy of the calcaneus to overcome eversion and added various supplementary procedures as indicated. Clark per-

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## TECHNIQUE OF OPERATION

A plastic lengthening of the tendocalcaneus is performed as a preliminary procedure so that the anterior end of the calcaneus can be elevated when the arch is raised. In the operation on the foot itself a slightly curved incision with convexity upward is made on its medial aspect from the shaft of the first metatarsal bone to the inferior extremity of the medial malleolus. The incision should pass superior to the medial aspect of the navicular bone. After the skin and superficial fascia are reflected, the larger branches of the medial tarsal artery in the region of the superior aspect of the navicular bone should be exposed under the deep fascia and ligated. The tendon of the tibialis posterior muscle is temporarily separated with a periosteal elevator from its attachment to the inferior surface of the navicular tuberosity. The medial one-half of the inferior surfaces of the navicular and first cuneiform bones are exposed in this dissection. A drill hole 6 or 7 millimeters in diameter is made vertically through the navicular bone lateral to the tuberosity from the superior to the inferior surface. The superior opening of the drill hole is made oval in shape with a gouge. A slot 2 millimeters wide is made with a gigli saw and very thin chisel from the drill hole to the posterior part of the medial surface of the navicular tuberosity. A small gouge is used to make a groove on the inferior surfaces of the first cuneiform and the navicular bones from the insertion of the tibialis anterior muscle to the drill hole at its inferior end. The sheath of the tibialis anterior tendon is exposed and incised in its distal 6 or 8 centimeters. After the tendon is freed down to its insertion, it is pulled posterior with a button hook and thrust through the slot in the navicular bone to a position in the drill hole and in the groove on the inferior surfaces of the navicular and first

TABLE I—SUMMARY OF EXPERIMENTAL WORK

Sol. no.	Hemorrhage	Heart	Monocyte & leukocyte	Time of scar appearance	Absorption of scar or resolution	Duration of scar	Remarks
I	0	0	2 wks	4 wks	3-4 mos	3-4 mos	Traces of matri 11 ft at end of 4 mo but scar practically gone
II	0	0	2 wks	4 wks	Slowly at 4 mos	4 mos	Early scar Matri 1 present with lesser at 4 mo M scale grad c 11 and edem at 22 wks
III	Plus 2	Plus 2	2-4 wks Polymorphs	Beginning to form at 4 wks			Discoloured
IV	Plus 3	Plus 1 through 4 wks	2 wks Polymorphs present Plus 2	4 wks	3-4 mos	3-4 mos	Good scar at 2 wks but less at 4 m
V	Plus 1	0	2 wks	2 wks	6-8 wks	6-8 wks	Dense scar early but after 6 to 8 wks though globular of aspect a solution present the scar is disappearing rapidly
VI	Plus 1 4 wks	Plus 1 4 wks	2-4 wks Pus cells Plus 1	2-4 wks 1 mo	Complete in 6-8 wks	4-6 wks	Moderately severe delayed reaction with poor scar formation in spite of prolonged inflammatory reaction

early as the third biopsy at 6 weeks. It will be seen that the scar tissue produced by Solution II—the phenol alcohol thuya solution—was the most enduring, but that even that scar tissue was beginning to disappear after 3 and 4 months in spite of the fact that the material was still seen in the tissues in microscopical sections.

This absorption of scar tissue after 4 months seems to offer sufficient evidence to explain clinical failures which show up between 4 and 6 months.

#### SUMMARY AND CONCLUSIONS

The injection method of treating hernia is with us probably to stay. That it has merit in certain cases cannot be denied. Hundreds, if not thousands of physicians have adopted it. Many cures have been effected. It cannot supplant surgery as a better method in the majority of instances, but it has its place, which is in the treatment of small indirect inguinal hernias. Other hernias should be repaired surgically. In 2 series of cases carefully selected as previously described, surgical repair would undoubtedly have a much lower incidence of recurrence than the injection method. This experiment would furnish a basis for comparison if in such a study one would pick out comparable cases from the series of patients treated by operation and by injection.

This method of treatment is not as simple and foolproof as the medical and pharmaceutical literature would lead one to believe. It is not without danger of serious complications even in experienced hands.

The ideal injection solution has not yet been developed. If the same dense progressive scar

tissue could be produced in the inguinal region that is produced in the lungs of silicosis cases the success of the injection treatment of selected hernias could probably be assured. An attempt to produce such a solution is now being made with various silica preparations.

The primary purpose of this report is to emphasize the necessity of following a strict technique and carefully selecting the hernias for treatment, injecting only those hernias which have a reasonable expectancy for cure. First the bad results following poor selection and ill advised injection treatment lead the method into disrepute.

The author is indebted to Mr. L. J. Rositer for his assistance in the preparation and interpretation of the microscopical slides.

#### BIBLIOGRAPHY

1. BERNIE, CLARENCE J. Factors influencing the treatment of hernia. *J. Am. Med. Ass.* 1935 110 1812-1813.
2. BRATTON, ARTHUR F. The ambulatory treatment of hernia. *Ann. Surg.* 1911 10, 324-334.
3. BERGER, CARL J. and COLLIER, PRUDEN I. Injection method of treating hernia. *Ann. Surg.* 1923 106 322.
4. CROWN, NATHAN N. The injection treatment of hernia. *J. Am. Med. Ass.* 1931 10, 549-544.
5. FOLLEK, S. H. Injection treatment of hernia. *I. Med.* 1936 5 405.
6. HAYES, F. I. and WHITE, A. S. Injection treatment of hernia. *California & West Med.* 1936 43 342.
7. MCKINNEY, FRANK S. An evaluation of the results of the injection treatment of inguinal hernia. *Ann. Surg.* 1937 105 338-343.
8. RICE, CARL O. The injection treatment of hernia. *Ann. Surg.* 1937 105 343-352.
9. WAGENSTEEN, OWEN H. The status of the injection treatment of hernia. *Ann. Surg.* 1937 105 322-324.

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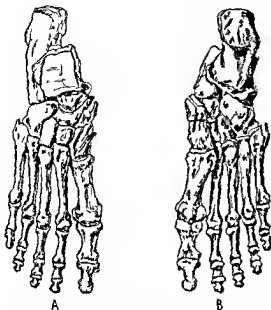


Fig 1 A Skeleton of the right foot from the superior aspect showing position of drill hole and slot in the navicular bone B Plantar view illustrating drill hole and slot from this aspect Attention is called to the shaded area which indicates the groove on the inferior surfaces of the navicular and first cuneiform bones



Fig 2 The tendon of the tibialis anterior muscle is looped through a drill hole in the navicular bone 1, Tendon of tibialis posterior 2 tendon of tibialis anterior 3 slot from drill hole to posterior part of medial aspect of navicular bone

cuneiform bones Two pronged instruments in the shape of the letter V on the end of a rod are useful to force the tendon through the slot The small chips of bone taken from the slot are replaced No retentive sutures are necessary because the tendon is firmly fixed in its new position The tendon of the tibialis posterior is replaced as near as possible to its original position

Following the operation, the extremity is immobilized with a plaster cast from the toes to the upper part of the thigh The ankle is fixed in its limit of dorsiflexion and the knee in 20 degrees



Fig 3 Case 3 Pre operative roentgenogram of right foot



Fig 4 Case 3 seven months after operation

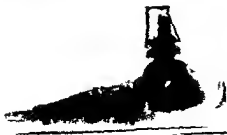


Fig 5 Case 5 Pre operative lateral view of right foot



Fig 6 Case 5 Four months after operation

of flexion. The sutures are removed through a window in the cast 2 weeks after operation. The cast is removed 7 or 8 weeks after the operation to allow firm healing of the tendocalcaneus. Obviously the operation on the foot itself would require immobilization only a short time after the incision has healed. It is important for the patient to be taught correct foot posture and gait. When walking is started the lateral side of the heel of the shoe should be lowered one-eighth to one-fourth inch, to prevent eversion strain for 6 months. Resistive exercises should be practiced daily in this interval to develop the tibialis anterior and tibialis posterior muscles.

This operation has been performed on six adolescent patients and one adult with satisfactory raising of the arch and correction of the eversion and abduction of the forefoot in each case. There has also been symptomatic relief in all cases. Originally it was thought that the procedure would be useful only in adolescents. Therefore in the pes planus of the adult the operation was performed on the right foot only with a heel cord lengthening on the left leg. The result of the flatfoot operation has been so satisfactory that operation on the left foot will be done.

One patient aged 11 years was a mulatto. As a school boy he complained of aching in his feet while standing and walking, and therefore sat on a bench while other boys played. Conservative treatment did not seem to offer much improvement in such a severe case and therefore the operation was performed, although criticism was expected for surgical treatment of a flatfoot in one of the colored race. However, the result was sufficiently good to justify the operation.

In this group of cases there were no wound infections. However, a hematoma developed in one case and the cause was traced to an injury of the branches of the medial tarsal artery during the exposure of the navicular bone. This is the reason for ligating the artery during the exposure. The first patient had more postoperative pain than the others because the sheath of the tibialis anterior tendon was not incised far enough in a proximal direction to free the tendon. This caused painful tension on the soft parts to which the tendon sheath was attached.

#### EFFECT OF OPERATION

This operation raises the arch of the foot by adding the power of the tibialis anterior muscle to that of the tibialis posterior near the point of primary insertion of the latter on the navicular bone. The tension on the tendon of the tibialis anterior from the position of its insertion, to the

inferior opening of the drill hole in the navicular bone, makes it act as a ligament in that part of its changed course. It re-enforces the first medial tarsometatarsal ligament and the plantar navicular cuneiform ligament and in that way helps prevent depression of the arch and abduction of the forefoot. The physiological effect of the operation is to so balance the muscle power of the foot that the weight of the body is sustained by the bones of the arch. Postural tonus of the muscles is all that is required to maintain this balance.

This operation should not be applied until after the age of 10 years because prior to that age ossification has not progressed sufficiently in the tarsal navicular bone. If performed before the navicular bone is ossified it is necessary to use a mattress suture of heavy chromic catgut to bind the two surfaces of the slot in the bone together.

When there is a contracture or spasm of the peroneal muscles, it will be necessary to perform a tenotomy or lengthen their tendons. It is obvious that this operation does not apply in most cases of rigid pes planus in which there are arthritic changes in the intertarsal joints.

#### CONCLUSIONS

1. Pes planus, not responding to conservative treatment, requires operative correction.
2. The arch may be raised by lengthening the tendocalcaneus and by changing the course of the tendon of the tibialis anterior muscle through a drill hole in the navicular bone to assist the tibialis posterior muscle.
3. The plantar navicular cuneiform and medial first tarsometatarsal ligaments are re-enforced by this procedure.
4. This operation changes the muscular forces which act on the foot, so that the superimposed weight is balanced on the bones of the arch by postural tonus.

#### BIBLIOGRAPHY

1. CLARK, W. A. A rebalancing operation for pronated feet. *J. Bone & Joint Surg.*, 1931, 13, 867.
2. FRISCH, O. VON. Die Gleich'sche Operation und ihre Bedeutung in der Therapie des Plattfusses. *Arch. f. Klin. Chir.*, 1908, 87, 324.
3. HOKK, M. An operation for the correction of extremely relaxed flatfeet. *J. Bone & Joint Surg.*, 1931, 13, 773.
4. LORD, J. P. Correction of extreme flatfoot. *J. Am. M. Ass.*, 1923, 81, 1502.
5. LOWMAN, C. L. An operative method for correction of certain forms of flatfoot. *J. Am. M. Ass.*, 1923, 81, 1500.
6. MILLER, O. L. A plastic flatfoot operation. *J. Bone & Joint Surg.*, 1927, 9, 84.
7. SOULE, R. E. Value of bone pin arthrodesis in the treatment of flatfoot. *J. Am. M. Ass.*, 1921, 77, 1871.



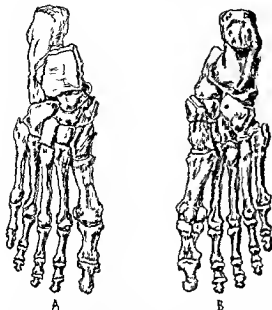


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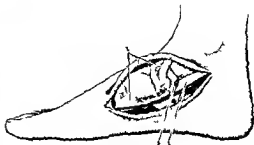


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Fig. 6 Case 5 Four months after operation

of flexion. The sutures are removed through a window in the cast 2 weeks after operation. The cast is removed 7 or 8 weeks after the operation to allow firm healing of the tendocalcaneus. Obviously the operation on the foot itself would require immobilization only a short time after the incision has healed. It is important for the patient to be taught correct foot posture and gait. When walking is started the lateral side of the heel of the shoe should be lowered one-eighth to one-fourth inch, to prevent eversion strain for 6 months. Resistive exercises should be practiced daily in this interval to develop the tibialis anterior and tibialis posterior muscles.

This operation has been performed on six adolescent patients and one adult with satisfactory raising of the arch and correction of the eversion and abduction of the forefoot in each case. There has also been symptomatic relief in all cases. Originally it was thought that the procedure would be useful only in adolescents. Therefore in the pes planus of the adult the operation was performed on the right foot only with a heel cord lengthening on the left leg. The result of the flatfoot operation has been so satisfactory that operation on the left foot will be done.

One patient aged 11 years was a mulatto. As a school boy he complained of aching in his feet while standing and walking, and therefore sat on a bench while other boys played. Conservative treatment did not seem to offer much improvement in such a severe case and therefore the operation was performed, although criticism was expected for surgical treatment of a flatfoot in one of the colored race. However, the result was sufficiently good to justify the operation.

In this group of cases there were no wound infections. However, a hematoma developed in one case and the cause was traced to an injury of the branches of the medial tarsal artery during the exposure of the navicular bone. This is the reason for ligating the artery during the exposure. The first patient had more postoperative pain than the others because the sheath of the tibialis anterior tendon was not incised far enough in a proximal direction to free the tendon. This caused painful tension on the soft parts to which the tendon sheath was attached.

#### EFFECT OF OPERATION

This operation raises the arch of the foot by adding the power of the tibialis anterior muscle to that of the tibialis posterior near the point of primary insertion of the latter on the navicular bone. The tension on the tendon of the tibialis anterior from the position of its insertion, to the

inferior opening of the drill hole in the navicular bone, makes it act as a ligament in that part of its changed course. It re-enforces the first medial tarsometatarsal ligament and the plantar navicular cuneiform ligament and in that way helps prevent depression of the arch and abduction of the forefoot. The physiological effect of the operation is to so balance the muscle power of the foot that the weight of the body is sustained by the bones of the arch. Postural tonus of the muscles is all that is required to maintain this balance.

This operation should not be applied until after the age of 10 years because prior to that age ossification has not progressed sufficiently in the tarsal navicular bone. If performed before the navicular bone is ossified it is necessary to use a mattress suture of heavy chromic catgut to bind the two surfaces of the slot in the bone together.

When there is a contracture or spasm of the peroneal muscles, it will be necessary to perform a tenotomy or lengthen their tendons. It is obvious that this operation does not apply in most cases of rigid pes planus in which there are arthritic changes in the intertarsal joints.

#### CONCLUSIONS

1. Pes planus, not responding to conservative treatment, requires operative correction.
2. The arch may be raised by lengthening the tendocalcaneus and by changing the course of the tendon of the tibialis anterior muscle through a drill hole in the navicular bone to assist the tibialis posterior muscle.
3. The plantar navicular cuneiform and medial first tarsometatarsal ligaments are re-enforced by this procedure.
4. This operation changes the muscular forces which act on the foot, so that the superimposed weight is balanced on the bones of the arch by postural tonus.

#### BIBLIOGRAPHY

1. CLARK, W. A. A rebalancing operation for pronated feet. *J Bone & Joint Surg*, 1931, 13, 867.
2. FRISCH, O. von. Die Gleich'sche Operation und ihre Bedeutung in der Therapie des Plattfusses. *Arch f klin Chir*, 1908, 87, 324.
3. HOKE, M. An operation for the correction of extremely relaxed flatfeet. *J Bone & Joint Surg*, 1931, 13, 773.
4. LORD, J. P. Correction of extreme flatfoot. *J Am M Ass*, 1923, 81, 1502.
5. LOWMAN, C. L. An operative method for correction of certain forms of flatfoot. *J Am M Ass*, 1923, 81, 1500.
6. MILLER, O. L. A plastic flatfoot operation. *J Bone & Joint Surg*, 1927, 9, 84.
7. SOULE, R. E. Value of bone pin arthrodesis in the treatment of flatfoot. *J Am M Ass*, 1921, 77, 1871.

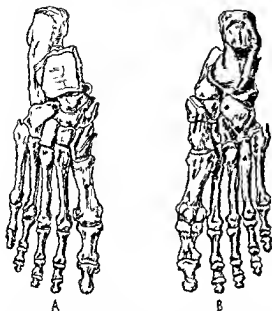


Fig. 1 A Skeleton of the right foot from the superior aspect showing position of drill hole and slot in the navicular bone. B Plantar view illustrating drill hole and slot from this aspect. Attention is called to the shaded area which indicates the groove on the inferior surfaces of the navicular and first cuneiform bones.

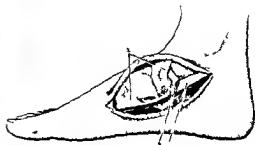


Fig. 2 The tendon of the tibialis anterior muscle is looped through a drill hole in the navicular bone. 1 Tendon of tibialis posterior. 2 Tendon of tibialis anterior. 3 Slot from drill hole to posterior part of medial aspect of navicular bone.

cuneiform bones. Two pronged instruments in the shape of the letter U on the end of a rod are useful to force the tendon through the slot. The small chips of bone taken from the slot are replaced. No retentive sutures are necessary because the tendon is firmly fixed in its new position. The tendon of the tibialis posterior is replaced as near as possible to its original position.

Following the operation the extremity is immobilized with a plaster cast from the toes to the upper part of the thigh. The ankle is fixed in its limit of dorsiflexion and the knee in 20 degrees



Fig. 3 Case 3 Pre-operative roentgenogram of right foot



Fig. 4 Case 3 Seven months after operation



Fig. 5 Case 5 Pre-operative lateral view of right foot



Fig. 6 Case 5 Four months after operation

universally successful in many cases. Even in those rarer unfortunate cases in which the infection has been bilateral, an uneventful clinical course followed the removal of both submaxillary salivary glands. RALPH COLP

## DISRUPTION OF WOUNDS AND POSTOPERATIVE HERNIA ARE PREVENTABLE

ONE of the requisites for a good surgeon is still sound anatomical knowledge. I may be wrong in my opinion that there is a growing tendency to drift away from the old school idea of the necessity for a profound anatomical training as a stepping stone to good surgery. Twenty years ago an article entitled "Anatomical Approach to the Long Bones" was published in one of our leading surgical journals. Though an apparently uninteresting subject it immediately attracted wide attention. It said that "the average general surgeon knows the anatomy of the abdomen but so rarely operates upon the extremities that he has forgotten the anatomy of these regions." This was near the truth, but I question the statement to the effect that surgeons know the anatomy of the abdominal wall, or possibly they know the anatomy but at least they do not respect it if one can judge from the complications and sequelæ of abdominal operations which can be traced to unanatomical abdominal incisions.

One is impressed by the modern surgeon's knowledge of the anatomy and function of the abdominal viscera and the skillful and extensive operations performed upon them, at the same time one is amazed at the complete disregard of the abdominal wall in making an approaching incision. The success of the skillfully done operation is often marred by disruption of the wound or a postoperative hernia. In an effort to eliminate these complica-

tions there has been expended by the profession no lack of effort and discussion directed to the repair of the abdominal wound irrespective of structures damaged, with the result that suture material has been condemned and a different technique in closure proposed.

From a study of the records of 9,000 consecutive abdominal incisions for disruption and hernia<sup>1</sup> it is quite evident that those incisions planned upon anatomical lines can be depended upon and should be preferred. It is general knowledge that the wounds which cause so much dissatisfaction are the vertical upper abdominal incisions, and still they continue to be made and continue to result in hernias and disruptions. The hernias result in disability and repeated operations and the disruptions have a mortality of 35 per cent. The surgeon who would be horrified by seeing the quadriceps muscle or the Achilles tendon cut across their fibers does not hesitate to cut the posterior sheath of the rectus muscle across its fibers without realizing that this structure is the tendinous continuation of the internal oblique and transversus muscle. The suturing of tendons elsewhere may result in end-to-end union if their corresponding muscles are put at rest in a relaxed position. But since the lateral abdominal muscles are respiratory muscles they cannot be put at rest, and if vomiting or coughing occur tremendous strain is thrown upon the sutured tendons which must give way in spite of any suture technique which may be used. Due to the action of these muscles the tension upon the upper abdominal wall is in a transverse direction. If the posterior sheath is split transversely in the direction of its fibers, even across the linea alba, the wall is not weakened. If the rectus muscle is retracted and preserved, as in the Sloan incision, the structures do not tend to separate, and disruptions and postoperative

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JUNE 1939

### TREATMENT OF DEEP INFECTIONS OF SUBMAXILLARY TRIANGLE

**I**NFECTIONS of the cellular tissues of the floor of the mouth deep to the submaxillary salivary gland, incorrectly called Ludwig's angina present a grave surgical condition in which energetic and radical treatment is essential. These patients as a rule are extremely ill. They are suffering not only from a profound toxemia of a virulent spreading cellulitis but also from the disastrous mechanical effects of an edematous submaxillary salivary gland pressing against the lateral pharyngeal wall and indirectly against the larynx. The diagnosis presents no difficulties. The skin over the submaxillary region while edematous and brawny, is rarely reddened. The swelling is stony hard and fluctuation is seldom obtained because the submaxillary salivary gland with its closely adherent superficial leaflet of the deep cervical fascia presents a dense unyielding barrier to the deep supuration which is present. The mouth is par-

tially opened with great difficulty. Forced movement of the protruded tongue, which is elevated and partially fixed is painful. Examination of the mucous membrane of the floor of the mouth reveals that it is brawny, indurated, edematous and tender.

There is no doubt that a number of these deep infections which are mild in character subside spontaneously under conservative treatment, but if the clinical condition of the patient is not improved within 24 hours immediate surgery is indicated.

If the published mortality of 40 per cent in this type of case is to be definitely lowered either the local buccal incisions, or the median one extending from the under surface of the chin to the hyoid bone must be discontinued. These incisions neither insure immediate and free drainage of the infected area nor stop the progress of the infection. This can be accomplished only by the extirpation of the submaxillary salivary gland under local anesthesia.

This gland automatically blocks the free drainage of the cellular tissues of the sublingual, the submaxillary and the retromandibular spaces. Following its removal with the division of the mylohyoid muscle at right angle to its fiber, the resultant cavity is loosely packed. After operation the change is dramatic. There is immediate definite improvement which is progressive. The patient feels distinctly better, swallowing becomes easier and dyspnea invariably disappears. The floor of the mouth soon loses its inflamed appearance.

Removal of the submaxillary salivary gland in infections of the floor of the mouth has been used routinely since 1922 and has been found

universally successful in many cases. Even in those rarer unfortunate cases in which the infection has been bilateral, an uneventful clinical course followed the removal of both submaxillary salivary glands. RALPH COLP.

## DISRUPTION OF WOUNDS AND POSTOPERATIVE HERNIA ARE PREVENTABLE

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hernia do not occur. The fact that during a period of 10 years preservation of the posterior rectus sheath has resulted in no defective wounds as compared to an experience of 5 per cent disruptions and 6 per cent abdominal hernias when the usual upper abdominal vertical incision in which the posterior sheath was cut across its fibers, gives us the authority to condemn the unanatomical vertical incision. As previously stated "Disruption of wounds and postoperative hernia in the upper

abdomen with the distressing consequences can be almost, if not completely, eliminated by the use of carefully made anatomical incisions. As a rule, busy surgeons are impatient to reach the diseased organ and resent the extra time and attention necessary to make anatomical incisions but the ease of closure, the feeling of security in regard to the wound and the added comfort of the patient more than compensates for the extra effort."

ALBERT O. SINGLETON

# THE SURGEON'S LIBRARY

## REVIEWS OF NEW BOOKS

THE *Compleat Pediatrician*<sup>1</sup> by Davison is a second and completely rewritten edition of a book which appeared first in 1934 and which was received with enthusiasm by pediatricians and men in general practice throughout the country. The author has made use of a unique method of presenting the subject. In his preface he states that the book was compiled with its emphasis on symptoms and signs as clues rather than on description, in the hope that it would be of value from a practical point of view.

The book is divided into 13 chapters. Symptoms and diseases are discussed in the first 7 chapters divided on the basis of the anatomical system chiefly involved and arranged in the order of their frequency. The first chapter, for example, is devoted to the "Respiratory Group" because in pediatric practice the largest incidence of disease is in this group.

These 7 chapters are followed by a very complete chapter on "Laboratory and Other Procedures Frequently Used in Pediatrics," a chapter on "Nutritional Requirements, Feeding and Diets," and chapters on "General, Fluid, Oxygen and Physical Therapy, and Pediatric Nursing," "Growth, Development and General Care of Children," "Physical Examination," and "Drugs and Prescriptions." In the front of the book immediately following the preface the author gives instructions for the proper use of the book. These instructions are necessary because use of the text would be difficult without knowledge of the meaning of all the reference numbers so freely used.

The book is designed to be a quick reference book for the practitioner, the student, and the teacher of pediatrics, and one that can be carried easily and be available when needed for purposes of diagnosis, therapy, and general information. It is a book that fills a very definite need in pediatrics and the present edition is a great improvement over the first.

A. H. PARMELEE

IN a compendium of 95 pages entitled *Maternal Care Complications*,<sup>2</sup> the American Committee on Maternal Welfare, Inc., has presented the essential facts relative to the 3 major causes of maternal mortality, viz. toxemias of pregnancy, obstetric hemorrhages, and puerperal infection.

The importance of prenatal care, the early recognition of toxic symptoms, and the institution of proper therapy are stressed under the toxemias. Under hemorrhages, the causes, early and late, are outlined and the type of treatment indicated in each condition is suggested. The prophylactic phase in the treatment of puerperal infection is naturally stressed.

There is little in this manual that cannot be found in any standard textbook of obstetrics, however, its brief, simple method of presenting these subjects will make it valuable as a quick ready reference for the practitioner when he is confronted with the problem of managing any of the above mentioned complications. The widespread distribution of this book would be of great value to the practitioner.

CHESTER C. DOHERTY

HELLNER'S recent monograph, *Die Knochengeschwulste*,<sup>1</sup> is the fruit of a ten year study of the bone tumors at the Surgical Clinic in Muenster. In 200 pages he discusses the tumors that involve the skeletal system under 4 general divisions. Approximately one-half the book is devoted to benign and malignant tumors of osseous origin. Then benign and malignant tumors of non-osseous origin that arise in close association with bones, such as those arising from the vascular system and marrow elements, are taken into consideration. The third major division is devoted to those tumors that derive their origin from the soft parts, mucous membranes, and fistulas and secondarily invade the bones. The so called periosteal fibrosarcoma is placed in that category. The last section is allocated to the various metastatic tumors of bone. The subject matter is presented from the clinical, roentgenological, and pathological points of view.

Hellner makes a plea for the standardization of the nomenclature of bone tumors. The author emphasizes the fact that diagnosis of bone tumors rests upon the correlation of the clinical observations, the roentgenological studies, and the pathological examination of the tissues. Tribute is paid to the Registry of Bone Sarcoma of the American College of Surgeons for its important contributions. The photographs, photographic reproductions of x-ray films, and photomicrographs with which the text is extensively illustrated are excellent. A comprehensive bibliography is appended. The book can be recommended as a concise review of the present knowledge of bone tumors.

FRANK E. STINCHFIELD.

<sup>1</sup>DIE KNOCHENGESCHWULSTE. By Dr. med. habil. Hans Hellner. Berlin: Julius Springer, 1938.

<sup>1</sup>THE COMPLEAT PEDIATRICIAN, PRACTICAL, DIAGNOSTIC, THERAPEUTIC, AND PREVENTIVE PEDIATRICS FOR THE USE OF MEDICAL STUDENTS, INTERNS, GENERAL PRACTITIONERS, AND PEDIATRICIANS. By Wilbur C. Davison, M.A., D.Sc., M.D. 2d rev. ed. Durham, N.C. Duke University Press, 1938.

<sup>2</sup>MATERNAL CARE COMPLICATIONS, THE PRINCIPLES OF MANAGEMENT OF SOME SERIOUS COMPLICATIONS ARISING DURING THE ANTEPARTUM, INTRAPARTUM, AND POSTPARTUM PERIODS. Approved by The American Committee on Maternal Welfare, Inc. Prepared by R. D. Mussey, M.D., P. I. Williams, M.D., and F. H. Falls, M.D., F. L. Adair, M.D., Editor. Chicago, Ill.: The University of Chicago Press, 1938.



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**A TREATISE ON THE SURGICAL TECHNIQUE OF OTO RHINO LARYNGOLOGY.** By Georges Portmann. Collaborators: H. Retrouvey, J. Despons, P. Leduc and C. Marquand. Translation by Pierre Viole M.D. Baltimore: William Wood & Co. 1939.

**ANGINA PECTORIS. NERVE PATHWAYS. PHYSIOLOGY, SYMPTOMATOLOGY AND TREATMENT.** By Heyman R. Miller M.D. Baltimore: The Williams & Wilkins Co. 1939.

**THE CLINICAL DIAGNOSIS OF SWELLINGS.** By C. E. Corrigan B.A. M.D., F.R.C.S. (Eng.) Baltimore: The Williams & Wilkins Co. 1939.

**ASSOCIATION FOR RESEARCH IN NERVOUS AND MENTAL DISEASE. Vol. 13 of a Series of Research Publications: THE CIRCULATION OF THE BRAIN AND SPINAL CORD. A SYMPOSIUM ON BLOOD SUPPLY.** The Proceedings of the 135th Session, New York, December 27 and 28, 1937. Baltimore: The Williams & Wilkins Co. 1937.

**GASTROINTESTINAL DYSFUNCTION.** By Barton Arthur Rhinehart A.B. M.D. Little Rock, Arkansas: Central Printing Co. 1937.

**PRIVY COUNCIL MEDICAL RESEARCH COUNCIL. Special Report Series No. 35. APPENDICITIS. A STATISTICAL STUDY.** By Matthew Young and W. T. Russell. London: His Majesty's Stationery Office. 1939.

**THE MEDICAL ANNUAL. A YEAR BOOK OF TREATMENT AND PRACTITIONER'S INDEX.** Fifty-Seventh Year. 1939. Bristol: John Wright & Sons Ltd. London: Simpkin Marshall Ltd. 1939.

**INTRACRANIAL TUMORS OF INFANCY AND CHILDHOOD.** By Percival Bailey M.D., Douglas N. Buchanan M.D., and Paul C. Bucy M.D. Chicago, Illinois: The University of Chicago Press. 1939.

**PHYSIOLOGY OF THE UTERUS WITH CLINICAL CORRELATIONS.** By Samuel R. M. Reynolds M.A. Ph.D. With forewords by George W. Corner M.D. and Robert T. Frank M.D. F.A.C.S. New York and London: Paul B. Hoeber Inc. 1939.

**LEHRBUCH DER RÖNTGENDIAGNOSTIK.** By H. P. Schinz, W. Baensch, and F. Friedl. 4th ed., rev. ed. Vol. 1.—SKELETT. Vol. 2.—INNERE ORGANE. Leipzig: Georg Thieme. 1939.

**VESTNÍK CHIRURGICKÉHO FAKULTNÍHO LÉKAŘSKÉHO ÚSTAVU.** Vol. 57, No. 1 and 2-3. Edited by Prof. Džanlidžić. Leningrad: Prospekt. Karla Libknechta. 44 log. 44. 1939.

**OXFORD MEDICAL PUBLICATIONS. THE MORPHOLOGY OF THE BRACHIAL PLEXUS WITH A NOTE ON THE PECTORAL MUSCLE AND ITS TENDON TWIST.** By Wilfred Harris M.D. F.R.C.P. New York and London: Oxford University Press. 1939.

**THE PHYSIOLOGY AND PHARMACOLOGY OF THE PILE. FIFTY BOOKS. Vol. 11.** By H. B. Van Dyke. Chicago, Illinois: The University of Chicago Press. 1939.

## CORRESPONDENCE

OBSTETRICAL DIFFICULTIES AFTER  
INFANTILE PARALYSIS

**A**N investigation of the obstetrical difficulties in patient who have had infantile paralysis is under way at the Hospital for Joint Diseases, 123d Street and Madison Avenue in New York City. This study is being pursued under a grant from the National Foundation for Infantile Paralysis.

For a proper evaluation it is essential that as many cases as possible be obtained for study and it is necessary therefore for the investigators to contact a large number of physicians throughout the country.

Drs. Samuel I. Feinberg and M. T. Horwitz at the above mentioned address would appreciate hearing from any physician who has a knowledge of any cases of this type.

# CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

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## PRELIMINARY PROGRAM FOR 1939 CLINICAL CONGRESS

THE surgeons of Philadelphia, under the leadership of strong and representative committees, are planning to present a program of operative clinics and demonstrations for the twenty-ninth annual Clinical Congress of the American College of Surgeons that will cover all phases of the clinical activities of this great medical center. During the five days, October 16-20, the clinicians at the five medical schools and more than 40 participating hospitals will demonstrate to their guests the latest advances in surgical technique and operative procedures. A preliminary schedule of the operative clinics and demonstrations at the hospitals and medical schools appears in the following pages. The program will be revised and amplified during the months preceding the Congress. Clinics will be held on the afternoon of Monday, October 16, and the mornings and afternoons of each of the following four days.

In addition to the ample and well-arranged schedule of operative clinics at which the technique of a wide variety of surgical procedures will be demonstrated in the operating rooms, the committee has arranged a series of non-operative clinics in many of the large hospitals for the presentation of important work being done in many special fields. There will be demonstrations and exhibits covering general surgery, genito-urinary surgery, neurosurgery, fractures and traumatic surgery, obstetrics and gynecology, broncho-esophagology, plastic and faciomaxillary surgery, surgery of the bones and joints, thoracic surgery, ophthalmology and otorhinolaryngology. These programs are being so correlated that the visiting surgeon may be assured of the opportunity to devote his time continuously, if he so desires, to clinics dealing with the special subject in which he may be most interested. The final program will be pub-

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lished and classified according to the various specialties in order to aid the visiting surgeon in the selection of the clinics which he desires to attend. A complete detailed clinical program will be posted in the form of bulletins at headquarters each afternoon for the succeeding day and published in printed form for distribution each morning.

The annual meeting of the governors and fellows of the College will be held in the Rose Garden of the Bellevue-Stratford Hotel on Thursday afternoon at 1:30 o'clock. Reports on activities of the College will be presented by the officers and chairmen of the standing committees.

The attention of fellows is called to the meetings of three important state and provincial committees to be held on Wednesday in the Palm Garden on the first floor of the hotel as follows: Judiciary committees, 9:30 a.m.; Credentials committees, 10 a.m.; Executive committees, 11 a.m.

The showing of surgical motion picture films which so faithfully depict clinical features of major interest to surgeons will be continued at this year's Congress. It is planned to present an enlarged program of both sound and silent pictures at daily exhibits in the Palm Garden of the headquarters hotel.

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LEHRBUCH DER RÖNTGENDIAGNOSTIK. By H. R. Schütz, W. Bensch, and F. Friedl. 4th ed., rev. ed. Vol. 1: Skelett. Vol. 2: Innere Organe. Leipzig: Georg Thieme. 1939.

ВЕТЕРИНАРНАЯ ХИРУРГИЯ ЖЕЛУДКА. Vol. 37, No. 1 and 2. Edited by Prof. Djanlidze. Leningrad: Izdatel'skaya Knizhnitsa. 44 log. 44. 1939.

OXFORD MEDICAL PUBLICATIONS: THE MORPHOLOGY OF THE BRACHIAL PLEXUS WITH A NOTE ON THE PECTORAL MUSCLE AND ITS TENDON TWIST. By Winifred Hamer, M.D. F.R.C.P. New York and London: Oxford University Press. 1939.

THE PHYSIOLOGY AND PHARMACOLOGY OF THE HEPATIC BODY. Vol. II. By H. B. Van Dyke. Chicago: Illinois: The University of Chicago Press. 1939.

## CORRESPONDENCE

OBSTETRICAL DIFFICULTIES AFTER  
INFANTILE PARALYSIS

An investigation of the obstetrical difficulties in patients who have had infantile paralysis is under way at the Hospital for Joint Diseases, 1233 Street and Madison Avenue, in New York City. This study is being pursued under a grant from the National Foundation for Infantile Paralysis.

For a proper evaluation it is essential that as many cases as possible be obtained for study and it is necessary therefore for the investigators to contact a large number of physicians throughout the country.

Dr. Samuel Kimberg and M. T. Horowitz at the above mentioned address would appreciate hearing from any physician who has a knowledge of any cases of this type.

be conducted an administrative panel round table discussion in which an effort will be made to cover as many aspects of hospital administration as possible with particular emphasis on maintenance of high professional standards, current economic problems and trends, and other timely subjects.

A special feature of the hospital conference will be a meeting of hospital executives on Tuesday evening when the program will deal with the future of the voluntary hospital, training of hospital administrators, etc.

At a joint session with the Association of Record Librarians of North America the subject of medical records will be considered from the standpoints of the various specialties of medicine and surgery.

There will be ample opportunity during the Congress for the visitors to inspect the hospitals in Philadelphia and vicinity.

#### ADVANCE REGISTRATION

The hospitals and medical schools of the Philadelphia area afford accommodations for large numbers of visiting surgeons, but to insure against overcrowding, attendance at the Congress will be limited to the number that can be comfortably accommodated at the clinics. The limit of attendance will be based upon the results of a survey of the operating rooms and laboratories of the hospitals and medical schools to determine their capacity for visitors. It is expected, therefore, that those surgeons who wish to attend the Congress will register in advance. A registration fee will be required in order to provide funds with which to meet the expenses of the Congress. A formal receipt will be issued to each surgeon registering in advance which is to be exchanged for a general admission card upon his registration at headquarters during the Congress. This card, which is not transferable, must be presented in order to secure clinic tickets and admission to scientific sessions.

A resolution adopted by the Board of Regents provides that the registration fee for fellows and endorsed junior candidates shall be \$5.00, that no fee for the 1939 Congress shall be required of initiates (class of 1939), that the fee for non-fellows attending as invited guests of the College will be \$10.00.

As in previous years, admission to clinics and demonstrations at the hospitals will be controlled by means of clinic tickets, which plan provides an efficient means for the distribution of visiting

surgeons at the various clinics and assures against overcrowding. The number of tickets issued for any clinic will be limited to the capacity of the room in which the presentation is held.

#### HEADQUARTERS—TECHNICAL EXHIBITION

Headquarters for the Congress will be established at the Bellevue-Stratford Hotel where there are unusual facilities for accommodating the Congress. The Grand Ballroom, Garden, Clover and Red rooms and other large rooms on the first and second floors and the roof have been reserved for scientific exhibits and conferences, registration, clinic ticket bureaus, bulletin boards, executive offices, etc. Thus, the activities of the Congress will be centralized under one roof.

The technical exhibition will be located in the Ballroom and adjacent rooms on the second floor. The registration and clinic ticket bureaus, together with the registration desk, will be centrally located on that floor. The bulletin boards, on which the daily clinical programs will be posted each afternoon, will be distributed through the exhibit rooms. Leading manufacturers of surgical instruments and supplies, x-ray equipment, operating room lights, hospital apparatus of all kinds, ligatures, dressings, pharmaceuticals, and publishers of medical books will be represented in the exhibition.

#### PHILADELPHIA HOTELS AND THEIR RATES

In addition to the headquarters hotel, the Bellevue-Stratford, there are many first-class hotels within a short walking distance, providing ample hotel facilities at reasonable rates. It is suggested that reservation of hotel accommodations be made at an early date at the following hotels which are recommended by the committee:

	Minimum rate with bath	
	Single	Double
Adelphia, 13th and Chestnut Sts	\$3 85	\$5.50
Barclay, Rittenhouse Square, E	4 50	7 00
Bellevue-Stratford, Broad and Walnut Sts	3 85	5 50
Benjamin Franklin, 9th and Chestnut Sts	3 85	5.50
Colonial, 11th and Spruce Sts	2 50	3.85
Drake, 1512 Spruce St	4 00	6 00
Majestic, Broad St and Girard Ave	2.50	4 00
Philadelphia, 39th and Chestnut Sts	2 75	4 40
Ritz Carlton, Broad and Walnut Sts	3 50	6 00
Robert Morris, 17th and Arch Sts	2 50	3 50
Spruce, 13th and Spruce Sts	1 50	2 50
St James, 13th and Walnut Sts	2 75	4 50
Sylvania, Juniper and Locust Sts.	3 00	5 00
Walton, Broad and Locust Sts	2 50	4 00
Warwick, 17th and Locust Sts	4 50	7 00
Wellington, 19th and Walnut Sts	4 00	6 00

## SCIENTIFIC SESSIONS

The scientific sessions will include certain new features introduced at the Congress in recent years which have met with *des red succès*. The schedule of midday panel discussions has been greatly extended in order that a larger number of the visiting surgeons may have an opportunity to participate.

On Monday the initiates will assemble in the Palm Garden at 11 a m in order that the officials of the College may meet them and explain in some detail the aims and objectives of the program of the College. At this same session, the fellowship roll will be signed by the initiates. In the evening, the Presidential Meeting and Convocation will be combined and at this time the new officers inaugurated and the initiates received into fellowship. Dr Howard C Naffziger, of San Francisco, will deliver the pre-idential address and distinguished surgeons from foreign countries will be introduced.

Scientific meetings will be held in Irvine Hall of the University of Pennsylvania on Tuesday, Wednesday and Thursday evenings in which medical men will co operate with the surgeons in presenting various phases of the interesting subjects which have been selected for presentation.

A, in former years, afternoon symposia have been arranged on the subjects of cancer, fractures and traumatic surgery, urology, obstetrics and gynecology and thoracic surgery. A special feature of the program includes a series of clinical demonstrations to be held at headquarters each morning for those visitors interested in the subjects of ophthalmology and otorhinolaryngology. The subcommittees in charge of these special arrangements are also planning extensive programs of operative clinics in surgery of the eye, ear, nose and throat to be held in the hospitals each afternoon. Programs for special evening sessions of these groups are being prepared for Tuesday and Thursday evenings.

The midday panel discussions have become of such major interest as a feature of the Congress that the series for this year's meeting will include 13 such sessions. The program will permit the formal and informal discussion of subjects in more restricted fields than would be susceptible of treatment in the general meetings. Attendance at these conferences will necessarily be restricted to the capacity of the rooms in which they will be held. Outstanding authorities have co-operated with the College in the presentation of each one of the selected subjects and will lead direct and participate in these discussions. The general plan to be followed is that the leader will present the

subject to be discussed within a ten minute period and selected men will discuss various phases of these topics briefly after which general discussion from the floor will be encouraged.

The program committee has aimed to include a selection of material at these various scientific meetings which will make it possible for all of the general surgeons and surgical specialists attending the Congress to learn of the newer developments in their respective specialties.

## GRADUATE TRAINING FOR SURGERY

Following the annual meeting of the fellows scheduled for Thursday afternoon, there will be a conference on graduate training for surgery at 3:00 p m. Raising the standards of surgery has been a primary purpose of the American College of Surgeons since its organization. This will be accomplished through the present program of the College which has stimulated added interest in this subject on the part of all its fellows and a large number of approved hospitals. The College Committee on Graduate Training for Surgery will present its report of activities for the year through its chairman, Dr Dallas B. Phemister, of Chicago. Also at this time, the list of hospitals approved for graduate training for surgery in the United States and Canada will be announced. Leaders in the field of graduate medical education will present and discuss at length the various phases and problems of organization and conduct of graduate training for surgery. This is on should be of vital interest to the entire fellowship of the College and many practical suggestions will be offered for developing the needed systematic supervision, preceptorship and guided instruction for young surgeons.

## HOSPITAL CONFERENCES

The twenty first annual Hospital Standardization Conference will open the Clinical Congress with a session in the Rose Garden at the Bellevue Stratford Hotel on Monday morning at 10:00 a m. Official announcement of the approved list of hospitals for 1939 will be made at this session.

On Monday afternoon and on Tuesday, Wednesday and Thursday, both mornings and evenings, an interesting program of papers, round table conferences and practical demonstrations, all dealing with various problems related to efficiency in the hospital will be presented. For Wednesday and Thursday afternoons at certain local hospitals there are planned demonstrations in administrative and technical procedures which will be of great interest to the hospital visitors. At the hospital conference on Tuesday afternoon there will

## MEMORIAL HOSPITAL

JAMES LEHMAN—9 Thyroid operations

## METHODIST EPISCOPAL HOSPITAL

CALVIN M SMYTH, JR and staff—9 30 Operations

## MISERICORDIA HOSPITAL

B R BELTRAN and E GARVIN—9 Operations  
GEORGE P MULLER, F MOGAVERO, and F T MCGINNIS  
—9 Operations

## MOUNT SINAI HOSPITAL

BENJAMIN LIPSHUTZ and staff—9 Operations

## NORTHEASTERN HOSPITAL

JOSEPH J TOLAND—9 Operations

## PENNSYLVANIA HOSPITAL

WALTER E LEE and staff—9 Operative and dry clinics

## PHILADELPHIA GENERAL HOSPITAL

L K FERGUSON and WILLIAM E ERB—9 Operative and dry clinics

Staff—2 Symposium on biliary and gastric diseases

L K FERGUSON Biliary surgery

TRUMAN G SCHNABEL Medical aspects of biliary disease

ERNEST BURVILLE-HOLMES X-ray aspects of biliary disease

W WAYNE BABCOCK Gastric surgery

WILLIAM EGBERT ROBERTSON Medical aspects of gastric disease

HERMAN OSTRUM X-ray aspects of gastric disease

WILLIAM BRODY Use of gastroscope in gastric disease

## PRESBYTERIAN HOSPITAL

EDWARD B HODGE, ERNEST G WILLIAMSON, and LYNN M RANKIN—9 Operative and dry clinics

## PROTESTANT EPISCOPAL HOSPITAL

I M BOYKIN and staff—9 Operations

## ST CHRISTOPHER'S HOSPITAL

HENRY KNOX, JOHN WOLF, and DR MARTIN—10 Pediatric surgery

## ST JOSEPH'S HOSPITAL

V G BURDEN—10 Operations

## ST LUKE'S AND CHILDREN'S HOSPITAL

DESIDERIO ROMAN, R W LARER, H K ROESSLER, A W HAMMER, JOHN BOWER, and staff—9 Operations

J W POST—9 Roentgenological examinations

O F BARTHELMER—9 Pathological and bacteriological demonstrations

## ST MARY'S HOSPITAL

W J RYAN and J J CANCELMO—9 Operations

V R MANNING—I Proctological clinic

## ST VINCENT'S HOSPITAL

J J CANCELMO—9 Cryptorchidism, its reduction by operative measures

## TEMPLE UNIVERSITY HOSPITAL

W WAYNE BABCOCK, G MASON ASTLEY, W EMORY BURNETT, and J NORMAN COOMBS—9 Operations

W EDWARD CHAMBERLAIN and staff—9 Radiological clinic

WILLIAM A STEEL and C HOWARD McDEVITT—2 General and emergency surgery

## WEST JERSEY HOMEOPATHIC HOSPITAL

H WESLEY JACK and staff—10 Operative clinic Cholecystectomy and appendectomy

## WOMAN'S MEDICAL COLLEGE HOSPITAL

J STEWART RODMAN and staff—10 Operations

## WOMEN'S HOMEOPATHIC HOSPITAL

LAWRENCE GOLDBACHER—3 Rectal surgery

*Wednesday*

## ABINGTON MEMORIAL HOSPITAL

Staff—2 Operations

## BROAD STREET HOSPITAL

A B WEBSTER and T. C GEARY Operations

## BRYN MAWR HOSPITAL

ARTHUR E BILLINGS and CHARLES H HARNEY—9 Operations

## CHESTNUT HILL HOSPITAL

WILLIAM B SWARTLEY, S DANA WEEDER, EDWARD F. McLAUGHLIN, and WILLIAM SWARTLEY RINKER—10 30 Operations

## COOPER HOSPITAL

PAUL M MECRAY, I E DEIBERT, F W SHAFFER, and R S GAMON—9 Abdominal and thoracic surgery, operative and dry clinics

## FITZGERALD-MERCY HOSPITAL

BASIL R BELTRAN—9 Operations

ALEXANDER E BURKE—9 Operations

## FRANKFORD HOSPITAL

BENJAMIN H CHANDLEE and RALPH W LORRY—9 Operations

## GERMANTOWN HOSPITAL

CHARLES F MITCHELL, WALTER E LEE, HARRY E KNOX, and THOMAS M DOWNS—10 Operations

## GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

WALTER E LEE—9 Operations

GEORGE M PIERSON, DR GRIFFITH, and WALTER E LEE—10 Dry clinic Calcified constricting pericarditis, medical and surgical aspects

JOSEPH T BEARDWOOD, JR, JOSEPH C YASKIN, and WALTER E LEE—11 Symposium Pancreatic adenoma with hyperinsulinism, metabolic, neurologic, and surgical aspects

COLLIER MARTIN—2 Lymphogranuloma venereum

## HAHNEMANN HOSPITAL

G A VAN LENNEP—9 Operations

## HOSPITAL FOR DISEASES OF STOMACH

SHERMAN A EGER—9 Clinic

HERBERT R HAWTHORNE, WILBUR W OAKS, and PAUL H NEESE—12 Clinic

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

E L ELIASON and staff—9 Operative and dry clinics

L K FERGUSON and DR LOEFFLAD—2 Varicose vein clinic

Staff of Harrison Department of Surgical Research—2 Recent advances in pre- and postoperative treatment

# PRELIMINARY CLINICAL PROGRAM

ARRANGED IN THE FOLLOWING SUBDIVISIONS GENERAL SURGERY, OBSTETRICS AND GYNECOLOGY, SURGERY OF BONES AND JOINTS, GENITO URINARY SURGERY, FRACTURES AND TRAUMATIC SURGERY, THORACIC SURGERY, NEUROSURGERY, BRONCHIO-ESOPHAGOGY PLASTIC AND FACIOMAXILLARY SURGERY, OPHTHALMOLOGY, OTORHINOLARYNGOLOGY

## GENERAL SURGERY

### Monday

#### HOSPITAL FOR DISEASES OF STOMACH

FRANCIS A MANTZ—1 Clinic

#### AMERICAN ONCOLOGIC HOSPITAL

JOHN W BRANSFIELD and GORDON CASTIGLIANO Cancer of breast operations and demonstration of cases

#### JEFFERSON HOSPITAL

HENRY K MONTLER—2 Therapeutics in surgery

#### MOUNT SINAI HOSPITAL

MOSES BEHREND and staff—1 15 Operations

#### PENNSYLVANIA HOSPITAL

DRYILL C KIRBY—3 Spinal anesthesia  
SAMUEL BRADBURY—4 Surgical follow up and group practice

#### PHILADELPHIA GENERAL HOSPITAL

HUBLEY R OWEN JOHN PAUL NORTH and LEWIS C MANGES—1 30 Operative and dry clinics  
Staff of Radiological Department—2 Tumor clinic  
I S HNELESKI—3 Management of blood bank at Philadelphia General Hospital  
PETER M LEWIS and staff—3 30 Treatment of varicose veins and complications

#### STETSON HOSPITAL

ROBERT S ALSTON C E SCHWARTZ and TROY MARTIN—2 Operations  
CARL F KOENIG—2 X ray clinic

#### TEMPLE UNIVERSITY HOSPITAL

CARROLL S WRIGHT—2 Dermatological and syphilitic demonstrations  
WILLIAM A STEEL and C HOWARD McDEVITT—2 General and emergency surgery  
HARRY Z HUBSHMAN HARRY E BACON and staff—3 Proctological clinic

#### WEST JERSEY HOMEOPATHIC HOSPITAL

H WESLEY JACK and staff—1 Operative clinic Cholecystectomy

### Tuesday

#### ABINGTON MEMORIAL HOSPITAL

JOHN EIMAN Discussion on the chemistry of surgery

#### AMERICAN ONCOLOGIC HOSPITAL

GEORGE M DORRANCE J W BRANSFIELD and FREDERICK A BOTHE Cancer of rectum operations and demonstration of cases  
JOSEPH McFARLAND Cancer of rectum pathological demonstration

#### BRYN MAWR HOSPITAL

JOHN B FLICK and FREDERICK R ROBBINS—9 Operations  
MAX STREUMER—2 Surgical pathology

#### CHESTNUT HILL HOSPITAL

JOHN F McCLOSKEY JAMES A LEHMAN J M ELLZEY, Jr and JOHN J SHORS—10 Operations

#### FITZGERALD MERCY HOSPITAL

JAMES A KELLY—9 Operations  
THOMAS J RYAN—9 Operations

#### FRANKFORD HOSPITAL

LOUIS D ENGLEBERTH—9 Operative and dry clinic

#### GERMANTOWN HOSPITAL

EDWARD B HODGE WILLIAM B SWARTLEY ROBERT S ALSTON and STEPHEN D WELDER—10 Operations

#### GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

WILLIAM BATES—9 Operations  
JOHN C HOWELL and I I GOPADZE—11 Operations

#### HAINEMANN HOSPITAL

A B WEBSTER—9 Operations

#### HOSPITAL FOR DISEASES OF STOMACH

HERBERT R HAWTHORNE WILBUR W OAKS and PAUL H NEESE—9 Clinic

#### HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

I S RAVEN and staff—9 Operative and dry clinics biliary tract diseases

#### JEANES HOSPITAL

Staff—11 Dry clinic  
W S HASTINGS A review of proposed methods of serological diagnosis of cancer  
A M DUFF JR The rapid diagnosis of fresh tissue  
HOKA WAMMOCK The control of pain of advanced cancer with irradiation  
G A WHITCOMB Presentation of treated oral lesions

#### JEFFERSON HOSPITAL

CHARLES F NASSAL—11 Operations ward walks  
GEORGE F MULLER—2 Operations  
J HALL ALLEN and BENJAMIN HASKELL—3 Proctologic surgery

#### LANKENAU HOSPITAL

D B FREESTER J MONTGOMERY DEEVER and DA MARTIN—9 Operative and dry clinics

## JEFFERSON HOSPITAL

THOMAS A SHALLOW and staff—11 Operations  
 HOBART A REIMANN—2 Medico-surgical problems  
 J HALL ALLEN and BENJAMIN HASKELL—3 Proctological operations

## JEWISH HOSPITAL

FRANK B BLOCK—9 Operations

## METHODIST EPISCOPAL HOSPITAL

CALVIN M SMYTH, JR and staff—9 Operations

## MISERICORDIA HOSPITAL

B R BELTRAN and E GARVIN—9 Operations  
 GEORGE P MULLER, F MOGAVERO, and F T MCGINNIS—9 Operations

## MOUNT SINAI HOSPITAL

BENJAMIN LIPSHUTZ and staff—9 Operations

## PENNSYLVANIA HOSPITAL

WALTER E LEE and staff—9 Operative and dry clinics

## PHILADELPHIA GENERAL HOSPITAL

LOUIS D ENGLERTH, S DALE SPOTTS, and HUGH ROBERTSON—9 Operative and dry clinics  
 L K FERGUSON and WILLIAM E ERB—9 Operations  
 Staff—9 Symposium on metabolic diseases  
 EDWARD S DILLON Surgical complications of diabetes mellitus  
 WILLIAM H ERB Diabetic surgery  
 ROBERT G TORREY Medical aspects of disease of thyroid gland  
 PATRICK A MCCARTHY Surgery of thyroid gland  
 Staff—2 Symposium on cancer preceded by follow-up cancer clinic  
 Staff—2 Symposium on general surgery  
 LAWRENCE CURTIS—2 Plastic repair after malignancy

## PRESBYTERIAN HOSPITAL

ELDRIDGE L ELIASON, FREDERICK BOTHE, and JOHN PAUL NORTH—9 Operative and dry clinics

## PROTESTANT EPISCOPAL HOSPITAL

E T CROSSAN and staff—9 Operations

## ST CHRISTOPHER'S HOSPITAL

HENRY KNOX, JOHN WOLF, and DR MARTIN—10 Pediatric surgery

## ST JOSEPH'S HOSPITAL

C S HERRMAN—9 Operations  
 L D ENGLERTH—10 Operations  
 V R MANNING—2 Proctological clinic

## ST LUKE'S AND CHILDREN'S HOSPITAL

DESIDERIO ROMAN, R W LARER, H K ROESSLER, A W HAMMER, JOHN BOWER, and staff—9 Operations  
 J W POST—9 Roentgenological examinations  
 O F BARTHMAIER—9 Pathological and bacteriological demonstrations

## ST MARY'S HOSPITAL

J J TOLAND, JR—9 Operations

## TEMPLE UNIVERSITY HOSPITAL

W WAYNE BABCOCK, G MASON ASTLEY, W EMORY BURNETT, and J NORMAN COOMBS—9 Operations  
 W EDWARD CHAMBERLAIN and staff—9 Radiological clinic  
 WILLIAM A STEEL and C HOWARD McDEVITT—2 General and emergency surgery.

## WEST JERSEY HOMEOPATHIC HOSPITAL

H. WESLEY JACK and staff—10 Operative clinic Repair of hernias  
 H WESLEY JACK and staff—1 Operative clinic Carcinoma of breast and appendectomy

## WOMAN'S HOSPITAL OF PHILADELPHIA

CALVIN M SMYTH, JR and staff—9 Operations

*Friday*

## ABINGTON MEMORIAL HOSPITAL

Staff—2 Operations

## AMERICAN ONCOLOGIC HOSPITAL

GEORGE M DORRANCE, W S NEWCOMET, and J W BRANSFIELD Cancer of mouth, operations and demonstration of cases

## BRYN MAWR HOSPITAL

WALTER E LEE and T MCKEAN DOWNS—9 Operations

## COOPER HOSPITAL

PAUL M MECRAY, I E DEIBERT, F W SHAFER, and R S GAMON—9 General, abdominal and thoracic surgery, operative and dry clinics

## FITZGERALD-MERCY HOSPITAL

BASIL R BELTRAN—9 Operations  
 ALEXANDER E BURKE—9 Operations

## GERMANTOWN HOSPITAL

CHARLES F MITCHELL, WALTER E LEE, HARRY E KNOX, and THOMAS M DOWNS—10 Operations.

## GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

WALTER E LEE—9 Operations  
 WALTER E LEE and HENRY LEBOY BOCKUS—11 Gastro-intestinal clinic

## HAHNEMANN HOSPITAL

THOMAS L DOYLE—9 Operations Plastic and general  
 HENRY S RUTH—2 Demonstration of sacral caudal block  
 JAMES D SCHOFIELD and staff—2 Operations

## HOSPITAL FOR DISEASES OF STOMACH

HERBERT R HAWTHORNE, WILBUR W OAKS, and PAUL H NEESE—9 Clinic  
 FRANCIS A MANTZ—1 Clinic

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

E L ELIASON and staff—9 Operative and dry clinics  
 L K FERGUSON, DR SHIEFFER, and LESTER H HERGESHEIMER—2 Lesions of the anus and anal canal

## JEFFERSON HOSPITAL

P BROOKE BLAND—9 Operations  
 JAMES L RICHARDS, THOMAS J COSTELLO, and DAVID M FARRELL—9 Operations  
 CLYDE SPANGLER—10. Ward rounds  
 LEWIS C SCHEFFEY and WILLIAM J THUDIUM—11:30 Uterine cancer follow-up clinic  
 JACOB HOFFMAN—12 Endocrinological clinic  
 NORRIS W VAUX and HOBART A REIMANN—12 Symposium Pulmonary complications in obstetrical and surgical practice  
 GEORGE P MULLER and staff—11 Operations  
 Staff—1 Regular meeting of tumor clinic, department of neoplastic diseases



## JEFFERSON HOSPITAL

GEORGE P. MULLER and staff—11 Operations  
 THOMAS A. SHALLOW—2 Operations Colon and rectum

## JEWISH HOSPITAL

RALPH GOLDSMITH—9 Operations  
 MOSES BEHREND—2 Operations

## LANKENAU HOSPITAL

GEORGE P. MULLER, GILSON C. ENGEL, JOSEPH O. KEEZEL,  
 and HANS MAY—9 Operative and dry clinics Plastic  
 and faciomaxillary operations by Dr. May

## MEMORIAL HOSPITAL

BRUCE L. FLEMING—9 Operations

## METHODIST EPISCOPAL HOSPITAL

GEORGE J. SCHWARTZ and staff—10 Operations

## MISERICORDIA HOSPITAL

JAMES A. KELLY and D. C. GEIST—9 Operations

## PENNSYLVANIA HOSPITAL

JOHN B. FLICK and staff—9 Operative and dry clinics  
 PAUL A. BISHOP—2 Acute intestinal obstruction with  
 x ray diagnosis and special reference to the Abbott tube  
 WILLIAM A. WOLFF and RUSSELL ELAYTON—4 Chemical  
 control of surgical patients

## PHILADELPHIA GENERAL HOSPITAL

W. WAYNE BARCOCK—9 Dry clinic  
 WILLIAM LEMMON—9 Operative clinic Gall bladder dis-  
 ease  
 JOHN O. BOWER, JOHN C. BURNS and HARRY B. TRACHTEN-  
 BERG—9 Exhibit on the use of No. 6000 catgut in sur-  
 gery management of spreading peritonitis due to per-  
 forated appendix with special reference to the use of  
 convalescent lymphophilic serum  
 HENRY S. RUTH—9 Choice of anesthetics in surgery

## PRESBYTERIAN HOSPITAL

WILLIAM BATES, JAMES B. MASOV and JOHN C. HOWELL  
 9 Dry clinic

## PROTESTANT EPISCOPAL HOSPITAL

M. L. ALLEN—9 X ray therapy of inflammation further  
 experience  
 I. M. BOYKIN—9 Problems in gall bladder surgery  
 R. L. LAYTON—9 Amputation in diabetic gangrene  
 R. H. MEADE, JR.—9 Acute pancreatitis

## ST JOSEPH'S HOSPITAL

CHARLES F. NASSAL—10 Operations

## ST LUKE'S AND CHILDREN'S HOSPITAL

DESIDERIO ROMAN, R. W. LARER, H. K. ROESSLER, A. W.  
 HAMMER, JOHN BOWER and staff—9 Operations  
 J. W. POST—9 Roentgenological examinations  
 O. F. BARTHAUER—9 Pathological and bacteriological  
 demonstrations

## ST MARY'S HOSPITAL

A. P. KEEGAN—9 Operations

## STETSON HOSPITAL

WILLIAM T. ELLIS and J. K. MARKS—12 Operations  
 CARL T. KOENIG—3 X ray clinic  
 ROBERT S. ALSTON, C. E. SCHWARTZ and TROY MARTIN—  
 2 Operations

## TEMPLE UNIVERSITY HOSPITAL

W. WAYNE BARCOCK, G. MASON ASTLEY, W. EMORY BLU-  
 NETT and J. NORMAN COOMBS—9 Operations  
 W. EDWARD CHAMBERLAIN and staff—9 Radiological  
 clinic  
 WILLIAM A. STEEL and C. HOWARD McDEVITT—2 Gen-  
 eral and emergency surgery  
 HARRY Z. HINSHMAN, HARRY E. BACON and staff—3  
 Proctological clinic

## WOMEN'S HOMEOPATHIC HOSPITAL

R. W. LARER—9 Operations  
 WILLIAM L. MARTIN—1 Operations  
 C. L. SHOLLENBERGER—1 Operations

## Thursday

## ABINGTON MEMORIAL HOSPITAL

DAMON B. PREFFER and staff—2 Dry clinic Peptic ulcer  
 and its surgical complications

## BRYN MAWR HOSPITAL

RALPH S. BROWER—9 X ray conference  
 J. STEWART RODMAN and ALAN P. PARKER—9 30 Opera-  
 tions

## CHESTNUT HILL HOSPITAL

WILLIAM C. SHEERMAN, L. H. HERGESHEIMER, HANS MAY  
 and H. P. MACNEAL—10 Operations  
 FREDERICK K. ALEXANDER—11 Intra abdominal hernia  
 x ray studies

## COOPER HOSPITAL

PAUL M. MCCRAY, I. E. DENBERT, F. W. SHAPER and  
 R. S. CAMON—9 General surgery and fractures op-  
 erative and dry clinics

## FITZGERALD MERCY HOSPITAL

JAMES A. KELLY—9 Operations  
 THOMAS J. RYAN—9 Operations

## FRANKFORD HOSPITAL

CHARLES F. NASSAL—9 Operations

## GERMANTOWN HOSPITAL

EDWARD B. HODGE, WILLIAM B. SHARTLEY, ROBERT S.  
 ALSTON and STEPHEN D. WEEBER—10 Operations

GRADUATE HOSPITAL OF UNIVERSITY OF  
PENNSYLVANIA

HERBERT R. HAWTHORNE—9 Operations

## HAFENMAN HOSPITAL

WILLIAM L. STALIS—9 Operations

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

I. S. RAYNER and staff—9 Operative and dry clinics gas-  
 tro intestinal disorders

## JFANES HOSPITAL

ROSCOE M. TEAHAN, HOKE WAMMOCK and CLARENCE A.  
 WHITCOMB—9 Operations Abdominopelvic resec-  
 tion of rectum excision of carcinoma of bladder im-  
 plantation of radon for carcinoma of mouth  
 Staff—11 Dry clinic  
 W. S. HASTINGS A review of proposed methods of sero-  
 logical diagnosis of cancer  
 A. M. DUFF, JR. The rapid diagnosis of fresh tissue  
 HOKE WAMMOCK The control of pain of advanced  
 cancer with irradiation  
 G. A. WHITCOMB Presentation of treated oral lesions

HOKL WAMMOCK The control of pain of advanced cancer with irradiation

G A WHITCOMB Presentation of treated oral lesions

### JEFFERSON HOSPITAL

P BROOKE BLAND—9 Gynecological operations

HARRY STUCKERT—10 Obstetrical ward rounds

JOHN B MONTGOMERY—12 Postoperative follow-up clinic

J B BERNSTINE and GEORGE B BLAND—12 Demonstration of vaccine prevention of puerperal sepsis

MARIO CASTALLO—12 30 Organization and conduct of obstetrical clinic for the treatment of syphilis and gonorrhea complicating pregnancy, results in ten years' experience

### KENSINGTON HOSPITAL FOR WOMEN

Staff—9 Gynecological operations

### PENNSYLVANIA HOSPITAL

NORRIS W VAUX and staff—9 Operations and demonstration of cases

NORRIS W VAUX and staff—2 Demonstration of Lying-In Hospital technique and procedure

SPOTSWOOD ROBINS Admission of patient and assignment to accommodation

J VERNON ELLSON Prenatal care

CRAIG WRIGHT MUCKLE Special clinics

ROBERT M SHREY Preparation of patient for labor

ROSS B WILSON Observation of patient in labor

CLIFFORD B LULL Delivery-room set-up, obstetrical technique and procedures

JOHN C ULLERY Care of the patient immediately post-partum

ROBERT A KIMBROUGH Care of the patient throughout puerperium while in the hospital

F SIDNEY DUNNE Follow-up and end results

PENDLETON TOMPKINS Out-patient clinic

RALPH M TYSON Care of the newborn

### PHILADELPHIA GENERAL HOSPITAL

C A BEHNEX—11. Dry clinic Gynecological

### PRESBYTERIAN HOSPITAL

GEORGE M LAWS, JAMES P LEWIS and DONALD RIEGEL—2 Gynecological operations

### PRESTON RETREAT

JOHN C HIRST—2 Demonstration of methods, results and clinical significance of studies of Vitamin A in pregnancy as indicated by visual purple estimation from the Feldman Adaptometer, surgical demonstration of technique of puerperal sterilization from first to fifth post-partum day by means of Pomeroy tubal ligation sterilization through the Pfannenstiel incision under local anesthesia, surgical demonstration of the new Pfannenstiel-B C Hirst-Kerr extraperitoneal cesarian section

### ST LUKE'S AND CHILDREN'S HOSPITAL

WARREN MERCER, LEONARD AVERETT, and staff—9 Operations

### ST VINCENT'S HOSPITAL

WILLIAM F MORRISON—10 Female gonorrheal clinic, administering cauterization and exhibition of cases which have been cauterized

### STETSON HOSPITAL

STEPHEN E TRACY and staff—9 Gynecological clinic

### WOMEN'S HOMEOPATHIC HOSPITAL

F L HUGHES—9 Gynecological clinic

### WOMAN'S HOSPITAL OF PHILADELPHIA

MARGARET CASTEX STURGIS and staff—9 Gynecological, sterility, operative and dry clinics

ALBERTA PELTZ and staff—9. Prenatal clinic

### Wednesday

### AMERICAN ONCOLOGIC HOSPITAL

STEPHEN TRACY, A VAUGHAN WINCHELL, and EMMET CICCONE Cancer of cervix, operations and demonstration of cases

### BRYN MAWR HOSPITAL

JAMES L RICHARDS—9 Gynecological operations, suspension of uterus and hysterectomy.

### CHESTNUT HILL HOSPITAL

EDWARD A SCHUMANN and CLAYTON T BEECHAM—9 30 Operations

### FITZGERALD-MERCY HOSPITAL

W BENSON HARER—9 Gynecological operations

### FRANKFORD HOSPITAL

GEORGE HANNA, JR and WALLACE MARTIN—1 30 Operative and dry clinics Obstetrical

### GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

W R NICHOLSON—9 Gynecological operations

COLLIER MARTIN—2 Lymphogranuloma venereum

### HAHNEMANN HOSPITAL

LEON CLEMMER and NEWLIN F PAXSON—2. Obstetrical operations

### HOSPITAL FOR DISEASES OF STOMACH

FRANCIS H EATON—2 Urethral lesions in women

### HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

CARL BACHMAN and staff—9 Obstetrical operations and demonstrations

DOUGLAS P MURPHY and PAUL O KLINGENSMITH—2 Round table discussion The relative importance of disproportion and inertia uteri in failed trial labor

### JEFFERSON HOSPITAL

BROOKE M ANSPACH, JOHN B MONTGOMERY, and staff—9 Operations

THADDEUS L MONTGOMERY, MARIO CASTALLO, and CLYDE SPANGLER—9 Operations

ARTHUR FIRST—12 Endocrin factors in the vitality and development of the fetus

ABRAHAM RAKOFF—12 New methods in the titration of prolactin and estrin; results of such titration in normal and complicated pregnancies

L G FEO—12 Studies in the parasitology and bacteriology of the vagina

LEOPOLD GOLDSTEIN—12 Glycogen content and acidity of the vagina in pregnancies and its complications

### MEMORIAL HOSPITAL

A W VOEGELIN—2 Gynecological operations

### METHODIST EPISCOPAL HOSPITAL

L C HAMBLOCK and staff—9 Obstetrical operations and demonstration of Caldwell-Morton apparatus for pelviography.

## JEWISH HOSPITAL

NORMAN S ROTHSCHILD—9 Operations  
HENRY TUMEN—9 Gastroscopic clinic

## LINKENAU HOSPITAL

GEORGE P MULLER GILSON C ENGEL JOSEPH O KEE  
ZEL and HANS MAY—9 Operative and dry clinics  
Plastic and faciomaxillary operations by Dr May

## MEMORIAL HOSPITAL

JAMES LEHMAN—9 Operations

## MISERICORDIA HOSPITAL

J A KELLY and D C GRIST—9 Operations  
T J RYAN—9 Operations and symposiums on peripheral  
vascular disease

## MOUNT SINAI HOSPITAL

BENJAMIN LIPSITZ and staff—9 Operations  
MOSES BEREND and staff—15 Operations

## PENNSYLVANIA HOSPITAL

JOHN B FLICK and staff—9 Operative and dry clinics

## PHILADELPHIA GENERAL HOSPITAL

PATRICK A MCCARTHY—9 Operative and dry clinics  
B P WIDMANN— Radium and x ray therapy

## PRESBYTERIAN HOSPITAL

HENRY P BAOWN and ORVILLE C KING—9 Operative  
and dry clinics

## PROTESTANT EPISCOPAL HOSPITAL

I M BOYKIN and staff—9 Operations

## ST JOSEPH'S HOSPITAL

JAMES A KELLY—10 Operations  
LEONARD MALLON Historical exhibit commemorating the  
ninetieth anniversary of St Joseph's Hospital

## ST LUKE'S AND CHILDREN'S HOSPITAL

DESMOND ROMAN R W LAMER H K ROESLER A W  
HAMMES JOHN BOWER and staff—9 Operations  
J W POST—9 Roentgenological examinations  
O F BARTHWATER—9 Pathological and bacteriological  
demonstrations

## ST MARY'S HOSPITAL

P A MCCARTHY—9 Operations  
J A FELLY and E H WEISS—9 Operations

## STETSON HOSPITAL

WILLIAM T ELLIS and J K MARKS—12 Operations  
CARL F LOEWIG—1 X-ray clinic  
ROBERT S ALSTON C E SCHWARTZ and TROY MARTIN  
—2 Operations

## TEMPLE UNIVERSITY HOSPITAL

W WAYNE BARLOCK G MASON ASTLEY W EMORY  
BUENETT and J NORMAN COOKS—9 Operations  
W EDWARD CHAMBERLAIN and staff—9 Radiological  
clinic  
CARROLL S WRIGHT— Dermatological and syphilo-  
logical clinics  
WILLIAM A STEEL and C HOWARD McDEVITT—3 Gen-  
eral and emergency surgery  
HARRY Z HENSELMAN and HARRY E BACON and staff—3  
Proctological clinic

## WEST JERSEY HOMEOPATHIC HOSPITAL

H WESLEY JACK and staff—10 Operative clinic Car-  
cinoma of breast  
H WESLEY JACK and staff—1 Operative clinic Appen-  
dectomy

## WOMAN'S MEDICAL COLLEGE HOSPITAL

J STEWART RODMAN—10 Operative clinic Breast  
HUBLEY R OWEN—10 Operative clinic Hernia  
JAMES LEHMAN—10 Operative clinic Thyroid

## OBSTETRICS AND GYNECOLOGY

## Monday

## MEMORIAL HOSPITAL

Z B NEWTON—2 Gynecological operations

## PHILADELPHIA GENERAL HOSPITAL

Staff of Radiological Department 2 Tumor clinic

## WOMAN'S HOSPITAL OF PHILADELPHIA

ELEANOR H BALPH and staff—1 Urological and gynec-  
ological clinic

## Tuesday

## BROAD STREET HOSPITAL

NEWLIN F PAXSON and MICHAEL J BENNETT—9 Dry  
clinic Gynecological

## BRYAN MAWR HOSPITAL

CHARLES A BENNEY—9 Gynecological operations

## COOPER HOSPITAL

T B LEE and GORDON F WEST—9 Operative and dry  
clinics Gynecological

## FITZGERALD MERCY HOSPITAL

JOSEPH V MISSETT—11 Gynecological operations

## HAHNEMANN HOSPITAL

NEWLIN F PAXSON and HENRY D LAFFERTY—9 Clinical  
pathological conference ward rounds Chronic nephritis  
and pregnancy placenta praevia x ray pelvimetry

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

CHARLES C NORRIS and staff—9 Gynecological oper-  
ations and demonstrations  
CHARLES C NORRIS and staff—2 Round table discussion  
The treatment of cervical carcinoma GEORGE GRAY  
WARD New York chairman

## JEANES HOSPITAL

ROSCOE M TEAHAN ROGER WAINWRIGHT and CLARE C A  
WHITCOMB—9 Operations Panhysterectomy for car-  
cinoma of uterine fundus application of radium for  
carcinoma of cervix vulvectomy for carcinoma radical  
neck dissection for metastatic carcinoma  
Staff—Dry Clinic—11  
W S HASTINGS A review of proposed methods of sero-  
logical diagnosis of cancer  
A M DURR JR The rapid diagnosis of fresh tissue

## WOMEN'S HOMEOPATHIC HOSPITAL

W C MERCER—9 Gynecological clinic

*Friday*

## BROAD STREET HOSPITAL

W C MERCER—Gynecological clinic

## BRYN MAWR HOSPITAL

JOHN B MONTGOMERY and THOMAS J COSTELLO—2 Resume of obstetrical clinic

## CHESTNUT HILL HOSPITAL

Z B NEWTON and H CURTIS WOOD—11 Operations

## FITZGERALD-MERCY HOSPITAL

W BENSON HARER—9 Gynecological operations

## HAHNEMANN HOSPITAL

HENRY L CROWTHER and RICHARD R GATES—10 Care of premature baby, management of abortion

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

CARL BACHMAN and staff—9 Obstetrical operations and demonstrations

CARL BACHMAN and staff—12 Round table discussion Treatment of abortion Philip F Williams, chairman

## JEFFERSON HOSPITAL

P BROOKE BLAND—9 Operations

JAMES L RICHARDS, THOMAS J COSTELLO, and DAVID M FARRELL—9 Operations

CLYDE SPANGLER—10 Ward rounds

LEWIS C SCHEFFEY and WILLIAM J TRUDYUM—11 30 Uterine cancer follow-up clinic.

JACOB HOFFMAN—12 Endocrinological clinic

NORRIS W VAUX and HOBART A REIMANN—12 Symposium Pulmonary complications in obstetrical and surgical practice

## KENSINGTON HOSPITAL FOR WOMEN

Staff—9 Obstetrical clinic and demonstration of the work of the Research Foundation

## MOUNT SINAI HOSPITAL

CHARLES MAZER and staff—9 Operations

## PENNSYLVANIA HOSPITAL

NORRIS W. VAUX and staff—9 Operations and demonstration of cases

## PHILADELPHIA GENERAL HOSPITAL

CHARLES S MILLER and FRANKLIN F OSTERHOUT—1 Operative and dry clinics Gynecological

## ST JOSEPH'S HOSPITAL

D S O'DONNELL—11 Operative and dry clinics

E W GILHOO—2 Operative and dry clinics

*Days to be Announced*

## JEWISH HOSPITAL

C J STAMM, JACOB WALKER, and PHILIP F WILLIAMS Operations

## PRESBYTERIAN HOSPITAL

CHARLES BEHNEN Operative and dry clinics Gynecological

PHILIP F WILLIAMS and COLLIN FOLKROD Operative and dry clinics Obstetrical

## TEMPLE UNIVERSITY HOSPITAL

FRANK C HAMBROD and staff Gynecological operative and dry clinics

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

*Scientific Exhibits—Laboratory of Obstetrics and Gynecology*

DOUGLAS P MURPHY Tokographic studies of uterine motility during pregnancy and labor

PAUL O KLINGENSMITH Exhibits showing the influence of variations in pelvic configuration upon the mechanism of labor

CARL BACHMAN Exhibits showing the techniques for the quantitative determination of estrogens and pregnandiol in pregnancy urine

FRANKLIN L PAYNE Hormone studies in hydatidiform mole and chorion epithelioma

F SIDNEY DUNNE Functioning ovarian tumors

## GENITO-URINARY SURGERY

*Monday*

## GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

JOSEPH C BIRDSALL and staff—2 Operative and dry clinics

## PENNSYLVANIA HOSPITAL

GARFIELD G DUNCAN—3 Management of diabetes during acute infections and surgical complications.

## ST JOSEPH'S HOSPITAL

WILLIAM J EZICKSON—2 Operative and dry clinics

## ST MARY'S HOSPITAL

W H HAINES—1 Operative and dry clinics

## TEMPLE UNIVERSITY HOSPITAL

W HERSEY THOMAS and staff—3 Operative and dry clinics

*Tuesday*

## GERMANTOWN HOSPITAL

STANLEY Q WEST and HAROLD S RAMBO—10. Operative and dry clinics

## GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

WILLIAM H MACKINNEY and EDWARD A. MULLEN—2 Operative and dry clinics

## HAHNEMANN HOSPITAL

LEON T ASHCRAFT and WILLIAM HUNTSICKEP, JR—2 Operations

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

ALEXANDER RANDALL and staff—2. Operations

## JEFFERSON HOSPITAL

D M. DAVIS—9 Diagnostic clinic, ward walk

**MOUNT SINAI HOSPITAL**

CHARLES MAZER and staff—9 Operations Exhibit  
*Investigative problems of the bitera marriage (motion pictures)*

**PENNSYLVANIA HOSPITAL**

NORRIS W. VAUX and staff—9 Operations and demonstration of cases

**PRESBYTERIAN HOSPITAL**

CHARLES BENVENY and JOHN GRIFFITH—9 Gynecological clinic

**ST JOSEPH'S HOSPITAL**

HARRY STUCKERT—11 Operative and dry clinics Obstetrical

J. F. CARRELL—2 Operative and dry clinics Obstetrical  
L. A. SOLOFF—3 Pathological demonstration

**ST MARY'S HOSPITAL**

L. J. WOJCIWYNSKI—9 Gynecological clinic  
F. J. CARRERAS—9 Obstetrical clinic  
J. M. J. AERTY—1 Obstetrical clinic  
W. H. SCHMIDT—1 Radiological clinic

**WOMAN'S HOSPITAL OF PHILADELPHIA**

ALBERTA FELTZ and staff—9 Prenatal clinic

**Thursday****BROAD STREET HOSPITAL**

NEWLIN F. PAYSON and MICHAEL J. BENNETT Operative and dry clinics Gynecological

**BRYN MAWR HOSPITAL**

J. O. GRIFFITH and J. J. HOWSON—2 Obstetrical clinic

**COOPER HOSPITAL**

T. B. LEE and GORDON WEST—9 Operative and dry clinics Gynecological

A. B. DAVIS and G. B. GERMAN—2 Operative and dry clinics Obstetrical

**FITZGERALD MERCY HOSPITAL**

JOSEPH V. MISSETT—11 Gynecological operations

**HAHNEMANN HOSPITAL**

EARL B. CRAIG and FRANK J. FROSCHE—9 Operative and dry clinics Gynecological 2 Operative and dry clinics Obstetrical

**HOSPITAL FOR DISEASES OF STOMACH**

TOBY A. GREGG—9 Interposition and Forthgill operations

**HOSPITAL OF UNIVERSITY OF PENNSYLVANIA**

CHARLES C. NORRIS and staff—9 Gynecological operations and demonstrations

CHARLES C. NORRIS and staff—2 Round table discussion  
The diagnosis and treatment of hydatidiform mole and chorion epithelioma

**JEANES HOSPITAL**

Staff—11 Dry clinic

W. S. HASTINGS A review of proposed methods of serological diagnosis of cancer

A. M. DUTT JR The rapid diagnosis of fresh tissue

HOWE WAMVOCK The control of pain of advanced cancer with irradiation

C. A. WHITCOMB Presentation of treated oral lesions

**JEFFERSON HOSPITAL**

LEWIS C. SCHEFFER, I. CHARLES LINTGEN and staff—9 Operations

CLYDE SPANGLER—10 Ward rounds

M. M. GINSBERG—10 30 Cystoscopic clinic

EDWARD BERT—11 Studies in fetal asphyxia

THOMAS L. MONTGOMERY—11 Intrapartum factors in fetal and maternal mortality

JOHN DUGGER—11 A study of the rupture of the uterus

Staff—12 Round table discussion The practical application of endocrine therapy in gynecological and obstetrical practice

Emil Novak Baltimore, chairman  
CHARLES LINTGEN—12 Postoperative follow up clinic  
BROOKE M. ANSPACH and LEWIS C. SCHEFFER—3 Clinical conference in gynecology

**MOUNT SINAI HOSPITAL**

BERNARD MANN and staff—9 Operations

**NORTHEASTERN HOSPITAL**

ALFRED DIENERT—10 Gynecological operations

**PENNSYLVANIA HOSPITAL**

NORRIS W. VAUX and staff—9 Operations and demonstration of cases

NORRIS W. VAUX and staff—2 Demonstration of Lying in Hospital technique and Procedure

SPENCER ROBINSON Admission of patient and assignment to accommodation

J. VERNON ELLSON Prenatal care

CRAIG WRIGHT MCKALE Special clinics

ROBERT M. SMITH Preparation of patient for labor

ROSE B. WILSON Observation of patient in labor

CLIFFORD B. LILL Delivery room setup obstetrical technique and procedures

JOHN C. ULLERY Care of the patient immediately post partum

ROBERT A. KENNEDY Care of the patient throughout puerperium while in the hospital

F. SYDNEY DUNN Follow up and end results

PENDLETON TOMPKINS Out patient clinic

RALPH M. TYSON Care of the newborn

**PRESBYTERIAN HOSPITAL**

GEORGE M. LAWS and staff—2 Gynecological operations

PHILIP F. WILLIAMS—2 Demonstration of prenatal clinic work

**ST JOSEPH'S HOSPITAL**

WILLIAM J. TRUDITH—11 Operative and dry clinics

**ST LUKES AND CHILDREN'S HOSPITAL**

WARREN MERCER LEONARD AVERETT and staff—9 Operations

**ST MARY'S HOSPITAL**

J. G. SABOL—9 Gynecological clinic

**STETSON HOSPITAL**

STEPHEN E. TRACY and staff—9 Gynecological clinic

**WEST JERSEY HOMEOPATHIC HOSPITAL**

C. F. HADLEY F. C. HESSERT and staff—10 30 Gynecological operations

**WOMAN'S MEDICAL COLLEGE HOSPITAL**

CATHERINE MACFARLANE—9 Gynecological clinic

MARGARET C. STURGIS—9 Ultrasoundography

AND GRAY TAYLOR and staff—1 Prenatal clinic

CATHERINE MACFARLANE—2 Gynecological clinic

## PHILADELPHIA GENERAL HOSPITAL

Staff—2 Operative and dry clinics

## ST LUKE'S AND CHILDREN'S HOSPITAL

E W CAMPBELL, L F MILLIKEN and staff—9 Operative and dry clinics

## TEMPLE UNIVERSITY HOSPITAL

W HERSEY THOMAS and staff—3 Operative and dry clinics

## WOMAN'S HOSPITAL OF PHILADELPHIA

FAITH S FETTERMAN and staff—9 Urological dry clinic

## SURGERY OF BONES AND JOINTS

*Monday*

## CHILDREN'S HOSPITAL

J T NICHOLSON—2. Operations

## MOUNT SINAI HOSPITAL

M B COOPERMAN—2 Operations

## PROTESTANT EPISCOPAL HOSPITAL

RUTHERFORD L JOHN—1 30 Operative and dry clinics

*Tuesday*

## COOPER HOSPITAL

B FRANKLIN BUZBY, OSWALD R CARLANDER, and DR WALLIS—9 Operative and dry clinics

## GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

DEFOREST P WILLARD, JESSE T NICHOLSON, and BENJAMIN T BELL—9 Operative and dry clinics

## ST. JOSEPH'S HOSPITAL

PAUL JEPSON—1 Operative and dry clinics

## ST LUKE'S AND CHILDREN'S HOSPITAL

JOHN A BROOKE—2 Operations

## SHRINERS' HOSPITAL

J R MOORE—2 Ward walk

## WOMEN'S HOMEOPATHIC HOSPITAL

E O GECKELER—1 Operative and dry clinics

*Wednesday*

## GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

W G ELMER, L D FRESCOLN, and PAUL JEPSON—12 Operations.

## JEFFERSON HOSPITAL

J T RUGH—9 Operations

## MOUNT SINAI HOSPITAL

M B COOPERMAN and staff—2 Operations

## PHILADELPHIA GENERAL HOSPITAL

Staff—2 Symposium on orthopedic surgery  
W G ELMER, L D FRESCOLN, and PAUL JEPSON—3 Operations

## PROTESTANT EPISCOPAL HOSPITAL

J W KLOPP—9 Fractures of neck of femur, use of nailing in treatment

RUTHERFORD L JOHN—1 30 Operative and dry clinics

## ST CHRISTOPHER'S HOSPITAL

RUTHERFORD L JOHN—10 30 Operations

## ST LUKE'S HOSPITAL

PAUL JEPSON—10 Operations

## SHRINERS' HOSPITAL

J R MOORE—9 Operations

## WEST JERSEY HOMEOPATHIC HOSPITAL

S L BROWN and staff—9 Operations

*Thursday*

## BRYN MAWR HOSPITAL

GEORGE WAGONER—9 Operations

## GERMANTOWN HOSPITAL

B FRANKLIN BUZBY and A D WALLIS—9 Operative and dry clinics

## HAHNEMANN HOSPITAL

JOHN A BROOKE, EDWIN GECKELER, and DONALD T JONES—2 Dry clinic Fractures of neck of femur, internal fixation, Smith-Petersen pin or parallel screws, results of leg shortening, herniation of intervertebral disc, shoulder disabilities, orthopedic problem cases for discussion

## PHILADELPHIA ORTHOPAEDIC HOSPITAL

DE FOREST P WILLARD and Staff—9 Operations

## ST JOSEPH'S HOSPITAL

PAUL JEPSON—1 Operative and dry clinics

## SHRINERS' HOSPITAL

J R MOORE—9 Out-patient clinic

## TEMPLE UNIVERSITY HOSPITAL

J R MOORE—1 Operations

*Friday*

## COOPER HOSPITAL

B FRANKLIN BUZBY, OSWALD R CARLANDER, and DR WALLIS—9 Operative and dry clinics

## JEWISH HOSPITAL

A M RECHTMAN, E A BRAV, HENRY SIGMOND, and M T HORWITZ—9 Dry clinic

## MOUNT SINAI HOSPITAL

M B COOPERMAN and staff—2 Operations

## ST CHRISTOPHER'S HOSPITAL

RUTHERFORD L JOHN—10 30 Operations

## SHRINERS' HOSPITAL

J R MOORE—9 Operations

*Days to be Announced*

## PRESBYTERIAN HOSPITAL

BRUCE GILL Operative and dry clinics

## JEWISH HOSPITAL

JOHN B. LOWNES—9 Operations  
LEON SOLIS COREN—9 Urological radiological exhibit.

## MOUNT SINAI HOSPITAL

MAURICE MUSCHAT and staff—130 Operations

## PROTESTANT EPISCOPAL HOSPITAL

A. E. BOTHE—2 Operations

## TEMPLE UNIVERSITY HOSPITAL

W. HERSEY THOMAS and staff—3 Operative and dry clinics

## U. S. NAVAL HOSPITAL

Staff—9 Operative and dry clinics

## Wednesday

## ABINGTON MEMORIAL HOSPITAL

ALEXANDER RANDALL and staff—9 Operations

## CHESTNUT HILL HOSPITAL

ALEXANDER RANDALL, FREDERICK S. SCHOFIELD and FRANK P. MASSANTSO—11 Operations

## COOPER HOSPITAL

D. F. BENTLEY and R. BERANCOURT—2 Operative and dry clinics

## GERMANTOWN HOSPITAL

JOHN B. LOWNES, F. S. SCHOFIELD and FRANK P. MASSANTSO—10 Operative and dry clinics

## HAINEMANN HOSPITAL

LEON T. ASHCRAFT and WILLIAM HUNSICKER, JR.—9 Operations

## JEFFERSON HOSPITAL

D. M. DAVIS and staff—9 Operations  
KARL KORNBUM—9 Roentgenological exhibit urological cases

## LANKEVAU HOSPITAL

C. A. W. UHLE—12 13 Rupture of the posterior urethra

## PRESBYTERIAN HOSPITAL

JOSEPH C. BIRDSALL, FRANCIS G. HARRISON and HENRY SANCHEZ—2 Operative and dry clinics

## ST. LUKE'S AND CHILDREN'S HOSPITAL

E. W. CAMPBELL, L. F. MILLIKEN and staff—9 Operative and dry clinics

## ST. MARY'S HOSPITAL

W. H. HAINES—2 Operations

## Thursday

## AMERICAN ONCOLOGIC HOSPITAL

A. E. BOTHE and EMILY CICCONO. Cancer of genito-urinary tract operations and demonstration of cases

## CHESTNUT HILL HOSPITAL

FREDERICK S. SCHOFIELD—9 Operations

## GERMANTOWN HOSPITAL

STANLEY Q. WEST and HAROLD S. RAMBO—10 Operative and dry clinics

HOSPITAL OF UNIVERSITY OF PENNSYLVANIA  
ALEXANDER RANDALL and staff—2 Operative and dry clinics

## JEFFERSON HOSPITAL

D. M. DAVIS and staff—9 Operations

## MEMORIAL HOSPITAL

E. A. WILLEN—3 Operations

## MISERICORDIA HOSPITAL

A. E. BOTHE—2 Operations

## MOUNT SINAI HOSPITAL

MAURICE MUSCHAT and staff—130 Operations

## PENNSYLVANIA HOSPITAL

LEON HERMAN and staff—2 Operative and dry clinic

## TEMPLE UNIVERSITY HOSPITAL

W. HERSEY THOMAS and staff—3 Operative and dry clinics

## U. S. NAVAL HOSPITAL

Staff—9 Operations  
Staff—3 Dry clinic

## WOMAN'S MEDICAL COLLEGE HOSPITAL

FATH S. FETTERMAN—9 Operative and dry clinics

## WOMEN'S HOMEOPATHIC HOSPITAL

LEON T. ASHCRAFT—230 Operative and dry clinics

## Friday

## ABINGTON MEMORIAL HOSPITAL

ALEXANDER RANDALL and staff—9 Operations

## BRYN MAWR HOSPITAL

LEON HERMAN and LEON GREENE—2 Operations

## GERMANTOWN HOSPITAL

JOHN B. LOWNES, F. S. SCHOFIELD and FRANK P. MASSANTSO—10 Operative and dry clinics

## GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

J. BIRDSELL—2 Operative and dry clinics

## HAINEMANN HOSPITAL

LEON T. ASHCRAFT and WILLIAM HUNSICKER, JR.—9 Operations

## JEFFERSON HOSPITAL

D. M. DAVIS and staff—9 Operations

## JEWISH HOSPITAL

JOHN B. LOWNES—9 Operations  
LEON SOLIS COREN—9 Urological radiological exhibit

## LANKEVAU HOSPITAL

WILLIAM H. MACINNERY and C. A. W. UHLE—2 Operations

## METHODIST EPISCOPAL HOSPITAL

STERLING MOOREHEAD and staff—10 Operations

## MISERICORDIA HOSPITAL

A. E. BOTHE—2 Dry clinic kidney tumors types and treatment

## THORACIC SURGERY

### *Tuesday*

HOSPITAL OF UNIVERSITY OF PENNSYLVANIA  
I S RAVDIN—2 Dry clinics Thoracic diseases

### JEFFERSON HOSPITAL

HOWARD H BRADSHAW and GEORGE WILLAUER—11 30  
Dry clinic Thoracic diseases

### MISERICORDIA HOSPITAL

J A SHARKEY—3 Talk on postpartum pulmonary complications

### PHILADELPHIA GENERAL HOSPITAL

Staff—9 Symposium on empyema, pneumonia, sulfamidamide, and sulfapyridine

E L ELIASON Empyema

RUSSELL S BOLES Pneumonia

ERNEST BURVILLE-HOLMES X-ray aspects of empyema and pneumonia

LEON SCHWARTZ Clinical studies on sulphapyridine

MOSES BEHREND, RICHARD H MEADE, JR, RUBIN M LEWIS, and ALBERT BEHREND—2 Operative and dry clinics The phrenic nerve, pneumonolysis, thoracoplasty, extrapleural pneumothorax

### *Wednesday*

### GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

WALTER E LEE—10 Dry clinic Constrictive pericarditis

### JEFFERSON HOSPITAL

HOWARD H BRADSHAW and GEORGE WILLAUER—2 Operative clinic Thoracic diseases

### PENNSYLVANIA HOSPITAL

JOHN B FLICK and staff—9 Operative and dry clinics Thoracic diseases

JOHN T BAUER—3 Carcinoma of the lung, diagnosis by sputum examination

### PHILADELPHIA GENERAL HOSPITAL

V W MURRAY WRIGHT—9 Wound and pulmonary complications, postoperative care

### PROTESTANT EPISCOPAL HOSPITAL

RICHARD H MEADE—9 Thoracoplasty for pulmonary tuberculosis, operative and dry clinics

### *Thursday*

### GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

J W CUTLER—2 Extrapleural and intrapleural pneumolysis in surgical therapy of tuberculosis

### PHILADELPHIA GENERAL HOSPITAL

MOSES BEHREND and staff—2 Operative clinic. Tuberculosis

### TEMPLE HOSPITAL

W EMORY BURNETT—9 Operative clinic Thoracic diseases

Staff—2 Dry clinics Thoracic diseases, followed by chest conference

## PLASTIC AND FACIOMAXILLARY SURGERY

### *Monday*

### CHESTNUT HILL HOSPITAL

CHARLES W GAISER—2 Operations

### *Tuesday*

### AMERICAN ONCOLOGIC HOSPITAL

GEORGE M DORRANCE and JOHN W BRANSFIELD—2 Operations

### JEFFERSON HOSPITAL

WARREN B DAVIS—9 Operations

### PENNSYLVANIA HOSPITAL

JAMES R CAMERON—2 Operations

### PRESBYTERIAN HOSPITAL

ROBERT IVY and LAWRENCE CURTIS—9 Operative and dry clinics, facial reconstructions

### *Thursday*

### AMERICAN ONCOLOGIC HOSPITAL

GEORGE M DORRANCE and JOHN W BRANSFIELD—2 Operations

### JEFFERSON HOSPITAL

WARREN B DAVIS—9 Operations

### *Friday*

### GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

ROBERT H IVY and LAWRENCE CURTIS—9 Operations

### MOUNT SINAI HOSPITAL

V FRANK—2 Operations

### ST JOSEPH'S HOSPITAL

WILLIAM J MCKINLEY—9 Operative and dry clinic

## BRONCHO-ESOPHAGOLOGY

### *Monday*

### CHESTNUT HILL HOSPITAL

CHEVALIER L JACKSON—3 Operations

### TEMPLE UNIVERSITY HOSPITAL

CHEVALIER L JACKSON—1 Broncho-esophagology

### *Tuesday*

### JEWISH HOSPITAL

L H CLERF, R M LUKENS, and C J SWALM—3 Bronchoscopic clinic

### PHILADELPHIA GENERAL HOSPITAL

GEORGE L WHELAN—9 Bronchoscopic clinic



## FRACTURES AND TRAUMATIC SURGERY

## Monday

## PROTESTANT EPISCOPAL HOSPITAL

I M BOYKIN—2 Fractures of lower third of leg industrial clinic

## Tuesday

## ABINGTON MEMORIAL HOSPITAL

Staff—3. Fracture clinic

## JEWISH HOSPITAL

MOSES BEHREND—9 Compound fractures immediate fixation and metal plates

RALPH GOLDSMITH and staff—9 Fracture clinic

## PRESBYTERIAN HOSPITAL

JOHN PAUL NORTH—9 Industrial surgery

## TEMPLE UNIVERSITY HOSPITAL

JOHN ROYAL MOORE—9 Fracture clinic

## WEST JERSEY HOMEOPATHIC HOSPITAL

H WESLEY JACK and staff—1 Operative and dry clinic discussion and presentation of four cases of traumatic removal of spleen

## Wednesday

## COOPER HOSPITAL

Staff—9 Clinic

## NORTHEASTERN HOSPITAL

T FURNER THOMAS—11 Moving picture demonstration

## PHILADELPHIA GENERAL HOSPITAL

CLAY MURRAY S HUDOCK, HARRISON McLAUGHLIN and B F BOZBY—2 Symposium

## ST JOSEPH'S HOSPITAL

JAMES A LERMAN—9 Industrial surgery living fascial suture in repair of hernia

## Thursday

## GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

ROBERT A GROFF—9 Responsibility of industry in the management of head injuries industrial surgery

BERNARD D JUMOVITCH—10 Industrial surgery Back injuries

JOHN C HOWELL—11 Industrial surgery Restoration of joint function after fractures pain in groin following lifting tendon repair

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

L F FERGUSON and LOUIS KAPLAN—1 Fractures

## JEWISH HOSPITAL

RALPH GOLDSMITH and staff—9 Fracture clinic

## MEMORIAL HOSPITAL

BRUCE L FLEMING—9 Fracture clinic

## PENNSYLVANIA HOSPITAL

FREDERICK R ROBBINS—9 Industrial clinic

## Friday

## COOPER HOSPITAL

K S GAMOV and E R RISTINE—9 Clinic

## ST MARY'S HOSPITAL

W J RYAN—9 Operative and dry clinics industrial surgery

## NEUROSURGERY

## Tuesday

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

FRANCIS C GRANT—9 Operations

## JEFFERSON HOSPITAL

WILLIAM DUANE JR—9 Operations

## TEMPLE UNIVERSITY HOSPITAL

TEMPLE FAY—9 Operations

## Wednesday

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

WALTER I LILLIE—10 Fundus changes associated with neurosurgical conditions

## MISERICORDIA HOSPITAL

T J RYAN—9 Operations and symposium on cranio-cerebral injuries

## TEMPLE UNIVERSITY HOSPITAL

TEMPLE FAY—9 Operations

## Thursday

## JEFFERSON HOSPITAL

WILLIAM DUANE JR—9 Operations

## Friday

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

FRANCIS C GRANT—9 Operations

## JEFFERSON HOSPITAL

BERNARD M ALPERT and WILLIAM DUANE JR—10 Brain tumors diagnosis and treatment

## PHILADELPHIA GENERAL HOSPITAL

Staff—9 Operations

## TEMPLE UNIVERSITY HOSPITAL

TEMPLE FAY—9 Operations

## GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

GEORGE M COATES and BENJAMIN H SHUSTER—2  
Otolaryngological and neuro-otological operative and dry clinics

## HAHNEMANN HOSPITAL

CHARLES B HOLLIS—2 Operations

## HOSPITAL FOR DISEASES OF STOMACH

ROBERT J HUNTER—2 Functional ear test.

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

GABRIEL TUCKER and staff—9 Direct laryngoscopy  
JULIUS WINSTON and D S BOSTWICK—2 Operations  
GABRIEL TUCKER—2 Dry clinic Laryngeal tumors, benign and malignant (Colored motion pictures)

## JEFFERSON HOSPITAL

L H CLERF—9 Cancer of larynx  
H. H. LOTT—9 Tonsil clinic  
H J WILLIAMS—1. Dry clinic Facial paralysis occurring during the course of chronic suppurative otitis media and its treatment

## LANKENAU HOSPITAL

RALPH BUTLER, ROBERT J HUNTER, and EDWARD H CAMPBELL—2 Operations

## METHODIST EPISCOPAL HOSPITAL

WALTER ROBERTS and staff—2 Operations

## MISERICORDIA HOSPITAL

R J BRENNAN—2 Talk on treatment of sinusitis

## MOUNT SINAI HOSPITAL

D N HUSIK—1 30 Operations

## PENNSYLVANIA HOSPITAL

ORAM KLINE, HENRY A MILLER, and HOWARD HEBBLE—2 Operations (out-patient clinic)  
ROMEO A LUONGO and ANTHONY C BRANCATO—2 Diagnostic methods in nose and throat conditions  
LOUIS E SILCOX—2 Tonsillectomy, general anesthesia

## PHILADELPHIA GENERAL HOSPITAL

LOUIS J BURNS—2 Laryngeal tuberculosis

## ST JOSEPH'S HOSPITAL

ARTHUR WRIGLEY—11 Operative and dry clinics

## ST. LUKE'S AND CHILDREN'S HOSPITAL

GEORGE MACKENZIE, SETH BRUMM, WILLIAM WHELAN, BENJAMIN SHUSTER, and staff—9 Operations

## ST MARY'S HOSPITAL

W. P. GRADY—9 Operative and dry clinics

## TEMPLE UNIVERSITY HOSPITAL

MATTHEW S ERSNER and staff—2 Otological clinic

## WEST JERSEY HOMEOPATHIC HOSPITAL

E S. HALLINGER and staff—2 Operations

## Wednesday

## CHESTNUT HILL HOSPITAL

JOHN R DAVIES, JR., GEORGE T FARIS, and DARIUS G ORNSTON—1 30 Operations

## CHILDREN'S HOSPITAL

F HAROLD KRAUSS—1. Sinus infections in children, diagnosis and treatment, out-patient clinic 3 Tonsil and mastoid operations

## FITZGERALD-MERCY HOSPITAL

J E LOFTUS—1 Mastoid operations

## GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

GEORGE B WOOD—2 Operative and dry clinics  
SAMUEL COHEN—3 Nasal plastic operation

## HAHNEMANN HOSPITAL

JOSEPH V CLAY—2 Operations

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

EDWARD H CAMPBELL and OSCAR BATSON—2 Operations

## JEFFERSON HOSPITAL

A T SMITH—10 Tumors of nose and sinuses  
H. J WILLIAMS—1 Operative and dry clinics

## JEWISH HOSPITAL

A. S KAUFMAN—1 Mastoid surgery

## MISERICORDIA HOSPITAL

C T MCCARTHY—2 Tonsillectomy, local, LaForce, dissection, submucous resection, simple and radical mastoid, results of sulphamylamide in mastoiditis

## PHILADELPHIA GENERAL HOSPITAL

ROBERT J HUNTER—2 Recent advances in otology, ward walk, laryngeal clinic

## PROTESTANT EPISCOPAL HOSPITAL

OTTO C HIRST and staff—2 Operations

## ST CHRISTOPHER'S HOSPITAL

F HAROLD KRAUSS and GOMER T WILLIAMS—2 Operations

## ST JOSEPH'S HOSPITAL

R L DICKSON—11 Operative and dry clinics

## ST LUKE'S AND CHILDREN'S HOSPITAL

GEORGE MACKENZIE, SETH BRUMM, WILLIAM WHELAN, BENJAMIN SHUSTER, and staff—9 Operations

## STETSON HOSPITAL

C H GRIMES and staff—12 Operative and dry clinics

## TEMPLE UNIVERSITY HOSPITAL

ROBERT F RIDPATH and staff—2 Rhinological clinic

## WEST JERSEY HOMEOPATHIC HOSPITAL

E S HALLINGER and staff—2 Operations

## WOMAN'S HOSPITAL OF PHILADELPHIA

CATHERINE ARTHURS and staff—2 Operations

## Thursday

## BRYN MAWR HOSPITAL

CHARLES A PRYOR—2 Operations

## FITZGERALD-MERCY HOSPITAL

CORNELIUS T MCCARTHY—1 Operations

PROTESTANT FRISCOLAL HOSPITAL  
WILLIAM A. LELL—2 Bronchoscopic clinic

### Wednesday

JEFFERSON HOSPITAL  
L. H. CLERF—9 Bronchoscopic clinic

MISERICORDIA HOSPITAL  
GABRIEL TUCKER, JOSEPH P. ATKINS and WILLIAM A. LELL—2 Operative and dry clinics

MOUNT SINAI HOSPITAL  
W. A. LELL and staff—10 Operative and dry clinics

PHILADELPHIA GENERAL HOSPITAL  
LOUIS H. CLERF—1 Bronchoscopic clinic, malignancy of air passages

WOMAN'S MEDICAL COLLEGE HOSPITAL  
EMILY VAN LOON and staff—9 Bronchoscopic clinic

### Thursday

FRANKFORD HOSPITAL  
GEORGE A. RICHARDSON—130 Bronchoscopic clinic

GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA  
GABRIEL TUCKER—9 Bronchoscopic clinic

JEFFERSON HOSPITAL  
L. H. CLERF—1 Bronchoscopic clinic

ST. CHRISTOPHER'S HOSPITAL  
EMILY VAN LOON—9 Bronchoscopy in allergic children

TEMPLE UNIVERSITY HOSPITAL  
CHEVALIER L. JACKSON—1 Bronchoesophagology

### Friday

GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA  
GABRIEL TUCKER and WALTER E. LEE—10 Esophageal diverticula surgical management

HOSPITAL OF UNIVERSITY OF PENNSYLVANIA  
GABRIEL TUCKER and staff—9 Bronchoscopic clinic

## OTORHINOLARYNGOLOGY

### Monday

BRYN MAWR HOSPITAL  
EDWIN P. LONGAKER—2 Operations

CHESTNUT HILL HOSPITAL  
B. D. PARIH, FRED E. TRACANZA and WILLIAM J. HITSCHLER—Operations

CHILDREN'S HOSPITAL  
WILLIAM HEWSON—2 Sinus infections in children diagnosis and treatment, out patient clinic  
LOYD S. HUTCHISON and MALCOLM N. WILKES—3 Tonsillectomy in children operations

GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA  
RALPH BUTLER and WALTER ROBERTS—2 Operative and dry clinics

HOSPITAL OF UNIVERSITY OF PENNSYLVANIA  
HARRY P. SCHENCK and LOUIS E. BRIDGES—2 Operations

JEWISH HOSPITAL  
H. M. GODDARD—2 Operative clinic, Submucous resections, tonsillectomies, maxillary sinus disease

MOUNT SINAI HOSPITAL  
M. S. LESNER—230 Operations

NORTHERN LIBERTIES HOSPITAL  
SAMUEL COHEN—2 Nasal plastic surgery

PENNSYLVANIA HOSPITAL  
WILLIAM HEWSON and THOMAS GOWEN—2 Operations (out patient clinic)  
EDWARD H. CAMPBELL—2 Diagnostic methods in nose and throat conditions (out patient clinic)

PHILADELPHIA GENERAL HOSPITAL  
HERBERT M. GODDARD—Tonsil and submucous clinic

PRESBYTERIAN HOSPITAL  
WALTER L. CARLIS, DOUGLAS MACFARLAN, RICHARD B. CARLIS and L. W. KEMNER—2 Operative and dry clinics

ST. JOSEPH'S HOSPITAL  
T. F. GOWEN—1 Operative and dry clinics

ST. MARY'S HOSPITAL  
E. J. MURPHY—1 Operations

TEMPLE UNIVERSITY HOSPITAL  
ROBERT F. RIDPATH and staff—2 Rhinological clinic

WOMAN'S HOSPITAL OF PHILADELPHIA  
HELENETTA TUCKER TAYLOR—Tonsillectomy and adenoidectomy

### Tuesday

COOPER HOSPITAL  
ORAN R. KLINE, ARNOLD A. HURST and staff—2 Operations

FITZGERALD MERCY HOSPITAL  
CORNELIUS T. MCCARTHY—Radical mastoidectomy report on three cases of lateral sinus thrombosis with recovery. Treatment of otolaryngological cases with sulphonamide

FRANKFORD HOSPITAL  
ROBERT WATT—130 Operative and dry clinics

GERMANTOWN HOSPITAL  
H. J. WILLIAMS, C. B. OWINGS, C. F. TOWSON, VALEN TINE MILLER and WILLIAM J. HITSCHLER—1 Operative and dry clinics

## MOUNT SINAI HOSPITAL

AARON BARLOW—4. Operations

## PENNSYLVANIA HOSPITAL

A G FEWELL—2 Fundus clinic

## PRESBYTERIAN HOSPITAL

H M LANGDON—2 30 Operative and dry clinics

## PROTESTANT EPISCOPAL HOSPITAL

ANDREW KNOX—2 Operative and dry clinics

## ST CHRISTOPHER'S HOSPITAL

J B FELDMAN—2 Squint clinic

## TEMPLE UNIVERSITY HOSPITAL

WALTER I LILLIE and staff—1 Operative and dry clinics

## WILLS HOSPITAL

J M GRISCOM, F. C PARKER, and T. A O'BRIEN—2 Operative and dry clinics

*Tuesday*

## CHESTNUT HILL HOSPITAL

GEORGE E BERNER—2 Operations

## GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

WILLIAM T SHOEMAKER—2 Operative and dry clinics

## HOSPITAL FOR DISEASES OF STOMACH

GEORGE H. DENNEY—1 Cataract cases

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

F H. ADLER—10 Dark adaptation

F. H ADLER—2 Operative and dry clinics

## JEFFERSON HOSPITAL

C E G SHANNON—2 Operative and dry clinics

## PHILADELPHIA GENERAL HOSPITAL

C R MULLEN—3 Operative and dry clinics

## PROTESTANT EPISCOPAL HOSPITAL

N M BRINKERHOFF—2 Operative and dry clinics

## ST CHRISTOPHER'S HOSPITAL

J B FELDMAN—2 Squint clinic

## ST JOSEPH'S HOSPITAL

THOMAS A. O'BRIEN—2 Operative and dry clinics.

## ST LUKE'S AND CHILDREN'S HOSPITAL

F C PETERS, S H BROWN, and staff—9 Operations.

## ST MARY'S HOSPITAL

F A MURPHY—1 Operative and dry clinics

## TEMPLE UNIVERSITY HOSPITAL

WALTER I LILLIE and staff—1. Operative and dry clinics

## WILLS HOSPITAL

LOUIS LEHRFELD, W S REESE, and C R MULLEN—2 Operative and dry clinics

*Wednesday*

## BRYN MAWR HOSPITAL

T DELORME FORDYCE—2. Operative and dry clinics

## GERMANTOWN HOSPITAL

CARL WILLIAMS and ALBERT SAUTTER—10. Operations

## GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

L. C PETER and staff—2. Operations

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

F. H ADLER—2 Operative and dry clinics.

## JEFFERSON HOSPITAL

C E G SHANNON—2 Operative and dry clinics

## LANKENAU HOSPITAL

PERCE DELONG and WILLIAM CREIGHTON—1 Operative and dry clinics

## PROTESTANT EPISCOPAL HOSPITAL

ANDREW KNOX—2 Operative and dry clinics

## PRESBYTERIAN HOSPITAL

H M LANGDON—2 30 Operative and dry clinics

## ST CHRISTOPHER'S HOSPITAL

J B FELDMAN—3 Operations

## ST LUKE'S AND CHILDREN'S HOSPITAL

F C. PETERS, S H BROWN, and staff—9 Operations

## WILLS HOSPITAL

J M GRISCOM, F C PARKER, and T A O'BRIEN—2 Operative and dry clinics

*Thursday*

## GRADUATE HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

WILLIAM T SHOEMAKER—2 Operative and dry clinics  
EDMUND B SPAETH—2. Plastic surgery of eye

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

EDMUND B SPAETH—10 Dry clinic

F H ADLER—2 Operative and dry clinics

## JEFFERSON HOSPITAL

C E G SHANNON—2 Operative and dry clinics

## MOUNT SINAI HOSPITAL

AARON BARLOW—4 Operations

## PHILADELPHIA GENERAL HOSPITAL

C R MULLEN—3 Operative and dry clinics

## PROTESTANT EPISCOPAL HOSPITAL

N M BRINKERHOFF—2 Operative and dry clinics.

## ST CHRISTOPHER'S HOSPITAL

J B. FELDMAN—2 Squint clinic

## ST LUKE'S AND CHILDREN'S HOSPITAL

F C PETERS, S H BROWN, and staff—9 Operations

## GERMANTOWN HOSPITAL

H J WILLIAMS C B OWINGS C E TOWSON VALENTINE  
MILLER and WILLIAM J HITSCHLER—2 Operations

GRADUATE HOSPITAL OF UNIVERSITY OF  
PENNSYLVANIA

RALPH BUTLER and WALTER ROBERTS Operative and dry  
clinics

## HAHNEMANN HOSPITAL

CHARLES B HOLLIS—2 Operations

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

EDWARD J DONNELLEY and HARRY SCHLUDERBERG—2  
Operations

## JEFFERSON HOSPITAL

A T SMITH—9 Tonsil clinic 1 Sinus clinic

## JEWISH HOSPITAL

H B COREY—1 Operations

## LANKENAU HOSPITAL

RALPH BUTLER ROBERT J HUNTER and EDWARD H  
CAMPBELL—2 Operations

## MEMORIAL HOSPITAL

HORACE WILLIAMS—1 Radical mastoid operations

## METHODIST EPISCOPAL HOSPITAL

WALTER ROBERTS and staff—2 Operations

## MISERICORDIA HOSPITAL

J E LOFTUS—2 Dry clinic Mastoid Surgery

## MOUNT SINAI HOSPITAL

MORRIS A WEINSTEIN—2 Operations

## PENNSYLVANIA HOSPITAL

WILLIAM HENSON ORAM KLINE and ROMEO LONGO—2  
Operations (out patient clinic)

WILLIAM HENSON HOWARD HERRLE and LOUIS E SILCOX  
—2 Diagnostic methods in nose and throat conditions  
EDWARD H CAMPBELL—2 Mastoid operations

## PHILADELPHIA GENERAL HOSPITAL

BENJAMIN H STUSTER—2 Laryngeal tuberculosis

## PROTESTANT EPISCOPAL HOSPITAL

ALLEN BERTOLET and staff—2 Operations  
OTTO C HIRST and staff—2 Operations

## ST LUKE'S AND CHILDREN'S HOSPITAL

GEORGE MACKENZIE SETH BRUMM WILLIAM WHELAN,  
BENJAMIN STUSTER and staff—9 Operations

## ST MARY'S HOSPITAL

E J HOLLAND—1 Operative and dry clinics

## TEMPLE UNIVERSITY HOSPITAL

MATTHEW S LEXNER and staff—2 Otological clinic

## WEST JERSEY HOMEOPATHIC HOSPITAL

F S HALLINGER and staff—2 Operations

## Friday

## CHILDREN'S HOSPITAL

EDWARD H CAMPBELL—1 Sinus infections in children,  
diagnosis and treatment out patient clinic 3 Mastoid  
operations

## FITZGERALD MERCY HOSPITAL

J E LOFTUS—1 Operations

## HOSPITAL OF UNIVERSITY OF PENNSYLVANIA

KARL M HOUSER and HARRY SCHLUDERBERG—2 Opera-  
tions

## PENNSYLVANIA HOSPITAL

THOMAS GOWEN and HENRY A MILLER—2 Operations  
(out patient clinic)

THOMAS GOWEN and EDWARD J GOUGH—2 Diagnostic  
methods in nose and throat conditions

THOMAS GOWEN and WILLIAM DANENOWER—2 Opera-  
tions Tonsil and mastoid

## PHILADELPHIA GENERAL HOSPITAL

DAVID N HUSIK—2 Operative and dry clinics

## ST CHRISTOPHER'S HOSPITAL

F HAROLD KRAUSS and GOMER T WILLIAMS—10 Opera-  
tions

## ST LUKE'S AND CHILDREN'S HOSPITAL

GEORGE MACKENZIE SETH BRUMM WILLIAM WHELAN,  
BENJAMIN STUSTER and staff—9 Operations

## ST MARY'S HOSPITAL

T J WALSH—1 Operative and dry clinics

## TEMPLE UNIVERSITY HOSPITAL

ROBERT F REDPATH and staff—2 Rhinological clinic

## WOMEN'S HOMEOPATHIC HOSPITAL

J R CRISWELL and C J V FRIES—2 Operative and dry  
clinics

## Days to be Announced

## ABINGTON MEMORIAL HOSPITAL

WALTER HUGHESON Demonstration of the physics of  
heating

FREDERICK KRAUSS Discussion on mastoids

## OPHTHALMOLOGY

## Monday

## COOPER HOSPITAL

J S SHIPMAN and staff—2 Operative and dry clinics

GRADUATE HOSPITAL OF UNIVERSITY OF  
PENNSYLVANIA

L C PETER—2 Dry clinic

HOSPITAL OF UNIVERSITY OF PENNSYLVANIA  
F H ADLER—1 Operative and dry clinics

## JEFFERSON HOSPITAL

C E G SHANNON—2 Operative and dry clinics

## LANKENAU HOSPITAL

PERCE DELONG—1 Operative and dry clinics

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- APPLETON ARTHUR B HAMILTON WILLIAM J and TCHAPEROFF, IVAN C C. Surface and Radiological Anatomy for Students and General Practitioners 254 Association for Research in Nervous and Mental Disease Vol. 17 of a Series of Research Publications. The Pituitary Gland: an Investigation of the Most Recent Advances. The Proceedings of the Association New York December 28 and 29 1936. Editorial Board Walter Tummie Angus M Frantz and Clarence C Hale 127
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